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SCIENCE AND THE SUPERNATURAL[1]

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I INTEND to make this discourse more modest than the title, and I trust you will find it so. Science is one, at least in its essential element, the method of reaching approximate truths. But scientists are many. On the topic before us it is preposterous for any man to speak for science as a whole and, by inference, for all scientists. We have scientists who still pray to the gods, scientists who laugh at the gods, and some who neither pray nor laugh, because they think they understand. I am sure all you expect of me this evening, and certainly all I intend to do, is to discuss the supernatural in the light that years of service in the science of physiology have given me. The topic of this discussion is not of my own selection. The views are my own. But they are neither unique nor original, except in the sense of being derived from cogitation on the common life, cogitations disciplined by years of research. I am not foolish enough to pretend that I am about to present to you anything that is both new and true. There are able tomes on the nature of science; and literature, *ad infinitum,* on the supernatural, especially in religions. There are able works on the conflicts between science and the supernatural. There are attempts at reconciliation of the supernatural with science. We have, in print, confessions of faith in traditional religions by otherwise competent scientists. We have, also in print, rejections of the supernatural by preachers and teachers of religion. I assume you are familiar with some, if not all, of this literature. Everything I am going to say has already been said, perhaps better, by other people. Nevertheless, here is the confession of a physiologist of lack of faith in the supernatural, and his reasons.

[1] William Vaughan Moody Lecture, University of Chicago.

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It is scarcely necessary, before this audience, to go into detail as to what we understand by science, although the term is frequently used loosely and with very different connotations. Probably the most common meaning of science is a body of established, verifiable and organized data secured by controlled observation, experience or experiment. Such data frequently lead to an approximate understanding of the causal relations between events, and these relations give us the so-called laws of science. To my way of thinking, the element in science of even greater importance than the verifying of facts, the approximation laws, the prediction of processes is the method by means of which these data and laws are obtained and the attitude of the people whose labor has secured them. In other words, the most important element in science appears to be the scientific method. What is the method of science? In essence it is this—the rejection *in toto* of all non-observational and non-experimental authority in the field of experience. No matter how high in state, church, society or science the individual may be who makes pronouncement on any subject, the scientist always asks for the evidence. When no evidence is produced other than personal dicta, past or present, "revelations" in dreams, or the "voice of God," the scientist can pay no attention whatsoever, except to ask: How do they get that way? If evidence is produced, he proceeds to examine the evidence. Does the evidence justify the conclusions or statements made? There is nothing recondite or abstruse in the method of science. To be sure, in many fields of scientific research methods of approach, methods of experimentation and data leading to certain or probable conclusions are becoming increasingly so recondite and specific that laymen in general and, in fact, scientists in other fields, are unable to follow, but the principle of the method is simple enough, and that this method of approach will give us the closest approximation to understanding and truth that we are able to reach to-day I think will be agreed to by all informed people.

The principle of the scientific method, in fact, is only a refinement, by analysis and controls, of the universal process of learning by experience. This is usually called common sense. The scientific addition to common sense is merely a more penetrating analysis of the complex factors involved, even in seemingly simple events, and the necessity of numerous repetitions and controls before conclusions are established. Where laymen, as a rule, do not understand or apply the scientific method is in the matter of controls. Thousands of honest errors have been committed and ludicrous conclusions promulgated by failure to understand the necessity of controls. Illustrative instances of this may be cited from the field where I have most experience, namely, physiology and disease. Fortunately, man recovers, as a rule, spontaneously from many diseases, such as colds, pneumonia, typhoid fever, headaches, diarrhea, etc. To be sure, some of these diseases may also lead to death, but if the person having these ailments does not die in the process of the malady, there is more or less complete recovery. Now, if the person not aware of this has the notion handed to him by his father, his priest or his mythology that holy water, holy oil, an amulet, a prayer, the killing of a goat or the laying on of hands will cure these diseases, experience will teach him that after applying any one or all of these measures to the sick persons many of them do get well. Indeed, applying all these to the sick might be a kind of control because a thinking person might be led to wonder which of these measures was the most potent in reestablishing health, and such questioning might lead him to try whether the person might recover without any of them. But usually this is not done. Those who believe that ill health can be cured by prayer will pray. Those who believe that an amulet is a cure will apply the amulet, and those who have faith in holy oil or laying on of hands will try these methods, and most of the people get well. A true statement of the facts is that sick persons so treated do get well after the treatment. The common error made is that the person recovers because of the treatment. The experience is correct. The conclusion is wrong. There is no control. The obvious control, of course, is a sufficient number of people of the same age with the same malady and none of the above measures applied, and the duration of their illness and percentage of recovery contrasted with the treated group. Until consciousness of the necessity of controls in all endeavors to ascertain new truths or in evaluating current theories, dogmas or practices, until this consciousness has become a compelling factor in society, man remains essentially unscientific no matter how much detailed scientific facts he may remember and how much scientific patter he may have absorbed. He is like the rooster who crows every morning before daybreak, notices that a little later the sun rises, and then concludes that it is his crowing which brings the sun above the horizon.

It seems that the supernatural in the sense of religions or a religious attitude toward nature and life is nearly universal among men at some stage of development. Science in the sense of elements of the scientific method, the learning by experience, is even more universal. It antedates man. The amoeba appears to work in part by the principle of trial and error; so do some of the higher animals, including the ape. This type of reaction or behavior in the

simpler forms of animal life does not necessarily connote conscious associative memories, but there is no good reason for denying the latter factor in the higher animals. The trial and error method is direct experience. Experience is experimentation in embryo. The very fact that every known race or tribe of humans has changed (some say progressed or improved) in the practical arts of living, in mores, in social organization and in religion is evidence of some learning by experience, despite all the retarding force of tradition and myths, and despite the absence of conscious control and analysis. Learning by experience, however, can not be dignified as science until a critical analysis of the factors and rigid controls of experience are introduced.

The *attitude* of the scientist is also an important factor in application of scientific method and therefore in the science itself, or at least in the growth of science.

This attitude is, of course, partly characterized by challenge of authority, be it man or God. It is further characterized by a serious attempt on the part of the scientist to control his own emotions and his own wishes in the matter. The scientist is, after all, an ordinary human being and the control of his desires, emotions or wishes in a problem is seldom, if ever, one hundred per cent. The scientist tries to rid himself of all faiths and beliefs. He either knows or he does not know. If he knows there is no room for faith or belief. If he does not know he has no right to faith or belief. He may have grounds for hypotheses, but the moment he begins to have faith in his hypotheses the hypotheses tend to become myths. One of my teachers in zoology used to say to us: "Friends, it is necessary, at present, to entertain theories in zoology, but we must be on our guard against being entertained by these theories." These elements of the scientific attitude I have indicated are scientific ideals which few, if any, scientists are able to attain all the time, particularly when they are dealing with matters of tradition or matters to which they are emotionally conditioned in early youth.

The term science is sometimes limited to the fields of mathematics, astronomy, chemistry, physics, geology, biology, and their practical applications. This may be due partly to the fact that in these fields we have to-day the greatest body of verifiable data and so-called laws of science. However, one of the elements in the scientific attitude is the application of the scientific method to the entire universe, including all human experience and all human relations. The man of science seeks for evidence in the case of all traditional beliefs and practices, and he must abstain from positive views when evidence is lacking in these fields just as he does when evidence is lacking in his own particular field of endeavor. Of course, it is much more difficult to apply the method of science to such fields as religion, social customs, political and economic institutions. Scientific controls are not readily devised or secured, but the application of the method of science in these fields has justified itself by results. It has afforded us a better understanding of the origin of our social heritage, even if it has not to date yielded any considerable body of verified data or laws similar to that of physics, chemistry, geology or biology. To the oft-repeated question—Are psychology, sociology, economics, etc., real sciences?—I would answer: They are, to the extent that the rigid application of the scientific method and scientific attitude is pursued by the people who cultivate these fields. The biologist is confronted in his own field by some of the difficulties that other scientists experience when they enter the fields of sociology, political science, psychology or religion. The past seems to be behind us despite the idea recently advanced that time may actually run backwards. Time may run backwards or in circles in the mind of the philosopher, but it does not seem to run backwards in biology. At any rate the history of the early ancestors of living plants and animals, and possibly the very origin of life itself, is only dimly written in the strata of the earth of bygone geological epochs. We may discover and describe a link here and there, but many of the links are as yet missing. We can not experiment with the past, we can not establish controls. Not only that, but many of the processes in the life of the individual man, animal or plant of to-day appear to be as complex, as difficult to analyze and separate and therefore control as the complex forces in society.

So much for science. If we have rightly understood and correctly outlined the method, attitude and scope of science, we might stop right here, and let you draw your own conclusions as to the supernatural, the "holy," the "divine." It might be better thus, for those of you who have already done so will be bored by the rest of this discussion; and others might take the conclusions on my mere say so, or reject them because contrary to their faith. In either case further discussion is largely futile.

The Supernatural as a Way to Knowledge

By supernatural we understand information, theories, beliefs and practices claiming origins other than verifiable experience and thinking, or events contrary to known processes in nature, such as the production of wine from water alone; the resurrection from the dead of persons in advanced stages of decomposition; accounts of creation of the world and of man by people who were not present at these events, and not in a position to infer from cosmic data; specific

codes of behavior enunciated directly to some man by some anthropomorphic god; arrest of the course of the sun through space so that the Jewish army could see to kill a few more natives; casting devils out of men, and sending demons into hogs; human pregnancies solely through non-material, that is, divine agencies; perpetual recurrence of a species of "immaculate conception" in that a divinity sends embryonic "souls" into every human fetus either at the moment of union of sperm and ova, or later in intrauterine life, etc., *ad infinitum, ad absurdum, ad nauseam.* This supernatural has been presented to man with varying degrees of clarity in a great variety of books and sermons by prophets, priests, and other holy men, in addition to the information in so-called sacred books, such as the Bible, the Koran, the Vedas and the book of Mormons. We all know that there are great variations among modern adherents of the sundry religions both in the amount that they individually accept and in interpretations put on what they do accept of this supernatural. But the supernatural in this sense is found at present in the theories, beliefs and practices of most, if not all, religious groups. We find a sprinkling of it here and there in social habits, customs and ethics. At one time it was prominent in political institutions and theory, but in most parts of the world "rule by divine rights" has been abolished, at least in theory. The gradual elimination of the supernatural and the divine in governments can not be primarily credited to science or scientists. It was forced by the travails of the common life. The supernatural sanction in social customs, habits or ethics frequently touches matters of relatively little importance, such as the interdiction of eating pork for the Jew, and the eating of meats on Friday for the Catholic, the ritual of baptism in the Christian religion, the circumcision in the Jewish religion, shaving or not shaving the face or the head, etc. The dogma that each individual marriage, when solemnized by a priest, is a "sacrament" made in Heaven by Almighty God and holds "till death do them part" has a more practical significance.

I am no authority in this field, but according to the best information now available it would appear that early mores had little or no connection with the supernatural. The grafting of the supernatural on ethics appears to come relatively late in human history. At any rate, so far as the essential mores of practical living is concerned, similar principles have been developed in various social groups independent of, parallel with, or under the influences of a variety of religious beliefs. These, therefore, have the sanctions of social necessity, convenience, or safety quite apart from the supernatural.

The supernatural is particularly abundant in the field of religions. I shall not attempt the impossible, *viz.*, a definition of religion. We have, however, people who entertain religious theories and follow religious rituals. When I speak of the Jewish, the Christian or the Mohammedan religions I refer to the theories, practices and attitudes peculiar to the people in these religious groups. I think we may get somewhere in the discussion if we treat religion in this way rather than by abstract definition. Most religions have in common the view and belief that some time somewhere God or gods, supernatural beings, communicated to man information on the origin and nature of the universe, on the origin and nature of man, on the nature and control of the forces of nature about us, on the nature of evil, etc. In most cases these so-called revelations occurred so long ago that the person or persons receiving them are buried in obscurity and myths. We can not analyze the alleged facts and circumstances. Fortunately, we have in this country two recent divine revelations of this type, namely, Mormonism on the basis of the Book of Mormons, and Christian Science on the basis of the divine teaching of Mary Baker Eddy. These are so recent that the personalities and the circumstances involved are not yet entirely obscured by myths and lore.

What has science to say to all this? The most serious aspect of the supernatural is, not the revelations, *per se,* the miracles, the myths and the guesses, but the injunction that all this must be taken on faith, that inquiry and doubt is tabu—that is, sin. A good deal of "revealed" information about the nature of the world and the nature of man has proved entirely erroneous. So far as the nature of the world and of man is concerned the revelations appear to be nothing but what could have been projected as guesses by any human contemporary of the revelations, on the basis of the knowledge and the ignorance of those times. The "revelations" have been of no aid in the advance of real knowledge of cosmognony, physiology, physics, chemistry or disease. On the contrary, they have, through human stupidity and obscenity, frequently aided in retardation. The revelations to Joseph Smith (the Book of the Mormons), the repeated revelations by Jehovah to Brigham Young, and the rise of Christian Science are recent. The character, education, intelligence and environment of the people concerned are fairly well known. In the light of all the known facts in these instances, is there any intelligent man or woman to-day, not steeped in childhood in the lore of Mormonism or Christian Science, who can have any respect for such revelations as a source of knowledge? When the Mormon leaders received a tip from God that po-

lygamy was ordered by him for his chosen people on earth (by the way, a revelation that is easy to take by the average human male), the United States Government did not hesitate to challenge God, or Brigham Young's sanity and veracity. The Federal Government was powerful and adamant and God yielded through a second revelation to the effect that he had changed his mind and polygamy was no longer according to the plan of God! In some cases the "revelations" are reported as coming through dreams; in other cases through brush fires; by direct writing of the finger of God on stones, or indirectly through oracles, popes, the flight of birds and the liver of slaughtered bulls.

The physiologist can not accept revelations from dreams any more than he can detect wisdom in hallucinations. The brush fire may reveal something of the nature of the world, but it can tell us nothing of the origin of man or the ways of the good life. The supernatural as a way to knowledge is in direct conflict with science.

That many intelligent people of to-day both inside and outside the religious groups reject much of the anthropomorphism of the gods and the more palpably absurd phases of the supernatural as a way to understanding is no news to you. They usually retain a distillate of the supernatural in form of beliefs in a "moral purpose" in the universe. And having injected human ethics into an obviously a-moral universe,[2] they endow man with personal immortality. This refined supernaturalism is still essentially anthropomorphic and homocentric. Even this form of the supernatural has no sanction in science or analyzed human needs, as I understand them.

THE CONTENT OF THE SUPERNATURAL REVELATIONS

So far we have considered the supernatural mainly from the aspect of the way of learning, the way of extending knowledge, the way of greater approximation to truth. A word or two on the content of the supernatural seems in place here. Most of the weird stories of creation of the universe, animals, man, of divine or demoniacal control of natural forces, of disease, etc., that have come to us *via* the supernatural route run contrary to facts now known, or rendered untenable, as possibilities, by known facts. Between the stories in the book of Genesis, as an article of faith, and the planetesimal hypothesis of Chamberlin and Moulton (probably the greatest intellectual achievement so far in the University of Chicago) as a working theory, science *must* choose the latter. Divine benevolence and wrath, devils and demons are not factors in health and disease, according to the data of modern medicine. Science and miracles are incompatible. Much happens in nature and in man for which science has yet no complete analysis of the causal chain. We recognize the unknown but not the unknowable. When we know that we don't know, that is itself an achievement, for then the field is cleared of the confusing and obstructing rubbish of tradition, and we are free to use all our ingenuity and imagination in contriving methods to find out. Miracles of sufficiently recent occurrence so that fair information is available of the alleged facts and circumstances are resolved into misrepresentation or misinterpretation of the facts. In regard to the recurring miracle of changing bread and wine into human flesh and blood by Christian rituals, biological and biochemical tests of the bread and wine after being subjected to such rituals reveal nothing but the original bread and wine. To persons fairly familiar with biology and physiology the theory of animal and human evolution and genetic relations is a closer approximation to what happened in the past than any guess or story in "sacred books" or mythology. I have a fair acquaintance with most of them.

The theory of dual nature of man (body and "soul") and its equal: The theory of *personal immortality* appears to be partly of mythological and supernatural origin, partly philosophical. The alleged objective evidence of these views is entirely mythological and supernatural, unless we are to dignify as evidence the ancient and modern communications with the dead by clairvoyance, "psychic mediums" and "ectoplasm." When examined, the "ectoplasm" appears to go the way of all errors and frauds. I know these attempts, and I am still skeptical.

Has science anything to say on the theory of personal immortality? The idea of persistence of the individual after physical death came down to us from the ancients in most if not all races. What credibility are we going to give to the idea solely because of its venerable age? So far as I can see, we can give no greater credibility to the ancients, views on immortality than to their views on other things about which they knew nothing. Conscious phenomena and intelligence in man, that is, personality, appear to be just as much an evolution of the material world as is the rest of the body processes. We seem to be forced to this conclusion from the evidence of the intimate dependence of all phases of consciousness, memory, and personality on the quantity and quality of the nervous system, and these, in turn, depend on all the rest of the body mechanisms.

[2] The concept of moral and immoral behavior has developed in connection with normal human adults or any hypothetical personality, to whom we ascribe consciousness of "right" and "wrong," and a feeling of freedom of choice in behavior. "*A-moral*" signifies the absence of these elements of personality, as in the behavior of young children, animals, the insane, and the physico-chemical forces of the universe.

It is perfectly true that we can cut off an arm or leg, remove certain peripheral ganglia and even a certain limited part of the central brain without seriously interfering with consciousness or personality. We can leave the brain structure anatomically intact, and through poisons eliminate consciousness temporarily or alter the individual personality permanently. The data from brain tumors, brain injuries, drugs, such as sedatives, hypnotics and anesthetics, experimental physiology, defective heredity, show that there is a close correspondence or dependence of consciousness, intelligence, memory or individuality on the nervous system.

What is personality? I think biologists would agree, to-day, that one element in personality is heredity, the kind of germplasm with which we are endowed at conception.

In the case of man and other mammals the original germplasm is subjected to months of intra-uterine environment. The latter is complex, not simple. Such material factors as the constitution, health and food of the mother appear to have a very real influence on the constitution of the fetus, and after birth such material factors as disease, accidental injuries, food, etc., may further materially modify the final product: man or woman.

The hereditary personality is further modified and built up gradually by experience and memory, so that to-day I am a somewhat different person from what I was twenty years ago. It seems at least highly probable, on the basis of biology, physiology and medicine, that this experience or the cumulative effect of the environment depends on changes built up mainly in the nervous system. The modifications of the nervous system called memory are less stable than the hereditary elements of the nervous organization. All the present evidence points to the fact that at death the nervous system goes to pieces with the rest of the body. Indeed, the disintegration of the nervous system, and with it the personality, may start before the death of the individual. The tragedies of "second childhood," of the aphasias, of senile dementia are known to all informed people. It doesn't make any difference whether the disintegration is fast or slow. We may preserve for a time some externals by desiccation, embalming or petrification. But fossils and mummies are as dead as the ashes of the funeral pyre. I can not conceive of events and environments in the future that would exactly reproduce my heredity and personal experience. Our basis of the known and the probable, immortality of the person is, at present, untenable. Leaving, for a moment, the realms of knowledge and reason and speaking of personal wishes, of likes and dislikes, the wish for personal immortality may be an extension of the pleasure in living, sometimes called "the will to live." The quantity of these emotions appears to vary in different people. Many seem to find comfort in the theory of "Nirvana," the state of everlasting unconsciousness. "Nirvana" may, without trickery or undue violence to reason, be translated into what modern biology indicates as the end of the individual, but the ways of attaining "Nirvana" appear to me incompatible with the good life here. As for other conditions of existence of the individual after death, other abodes of the "souls," the sundry infernos arouse in me, not fear, but pity and wonder how man can choose to torture his mind with such cruel absurdities; and I have not seen any heaven described where I care to go. My forebears had their Valhalla with its mead, its roast pork, its combats; the American Indian his happy hunting grounds; the followers of Mohammed their haven of houris; the Christian has his golden city of many apartments, his golden harp and his oriental worship of adulation. But hunting means destroying fellows not so very different from ourselves. A heaven of mead and pork and fights and females forever leaves me cold. Flowers, though they like ourselves last but for the moment, are finer than gold, and justice seems a better goal than worship. When the shadow lengthens I am content to call it a day and leave the work to others. The passing of personal immortality seems to have added interest to my work to-day, greater interest in my students, in my fellow men, in other things that seem worth-while human efforts. For when I die, I will be a long time dead.

I am perfectly well aware that many able and fine people inside and outside this hall will arise with impatience, if not in anger, and say: "Your analysis of the supernatural refers to an extinct species. It does not apply to religions or religious people of to-day. You are belaboring a man of straw." What are the facts? Is supernaturalism a thing of yesterday? Have the peoples of the earth ceased to chant every variant of the tune, "The old time religion is good enough for me"? If the orthodox Jew (and that embraces most of the Jews) has dethroned Jehovah, and rejected the Bible, I have not heard of it. According to the latest news the Pope is still God's viceroy among men and the faithful Roman Catholics still believe that the voice of the Vatican is the voice of God. The acceptance of the whole Bible as divine truth is not a rarity among Protestant Christians. The God of the Jews, the Christians and the Mohammedans in 1930 is not a fossil. Enter almost any religious service and you get an earfull of ancient and modern supernaturalism anent the soul, the devil, hell and heaven, sin, redemption, almighty Gods, angels, divine purposes, prayer. Is the supernatural

extinct? Take a look on and about this campus, and you will find a very prolific and very recent growth of chapels and churches: edifices, I am delighted to note, only in part dedicated to the rituals of the "God of old." To be sure the supernatural is not in our federal constitution. But it is not absent from state and municipal codes. "Acts of God" are embalmed in legal lore. Physiology and biology can not be taught at public expense in the states of Tennessee, Arkansas and Mississippi because it conflicts with "revelation." Is supernaturalism dead? What I have said here to-night would subject me to arrest and imprisonment in the state of Massachusetts, and disqualify me as a witness in court in at least six other states in the Union. Yes, my friends, supernaturalism is dead, indeed! Let a Jew, a Roman Catholic, a Mohammedan, or a man of no belief, like myself, run for governor in any state south of the Mason and Dixon line (and possibly in some states nearer home), or for President of the United States and he will discover something! The world has, indeed, moved since the days of Galileo, but in some places it has not moved very far. Why, the handful of liberal and informed people who have worked their way out of the cocoon of supernaturalism does not even make a respectable leaven in the college graduate group!

President Hoover, an engineer, and therefore at home in science, stated in his recent Thanksgiving proclamation: "We have been blessed with distinctive evidence of Divine favor. As a nation, we have suffered far less than other peoples from present world difficulties." This statement appears to imply that a divinity controls economic contingencies and rainfall, and either that we as a nation are morally more worthy than other peoples harder hit by economic and natural events of the past year, or else that this divinity is unfair in decreeing punishments and favors.

According to several Italian churchmen, the recent disastrous earthquakes in Italy were caused, not by unbalanced stresses in the crust of the earth, but by the Christian God, as punishment for the sins of men, women and little children in the devastated areas! Granted, for the sake of the argument, that the bishops are right and modern geology is wrong about earthquakes, we may still ask for evidence that men, women and little children living in earthquake areas are greater sinners than people living elsewhere; and again, if questioning was not tabu, how can a *just* and *loving* god institute such indiscriminate punishment? How can a *just* and *almighty* God permit such catastrophes to occur?

Within the present year five Protestant pastors in our neighboring state, Kentucky, are reported to have published the following statement: "God will and can answer prayer for rain. God has never withheld rain from the earth except in a gracious effort to bring his own people back to the ways of righteousness and holiness." If there is a God both almighty and just, prayer for rain and all kinds of favorable weather anywhere is unassailable. But if rain is sent to earth in proportion to holiness and prayer to Jehovah, the sundry heathens and all worshipers of "false gods" would have a dry time, not to speak of plants and animals who, according to the Bible, have no souls to pray with. Unfortunately for that kind of faith, the rainfall in heathen Philippines (that is, before the introduction of Christianity) was greater than in our Christian state of Tennessee. But this question need not be left in the realm of faith and controversy. It can be settled by controlled observation. What is the ratio of rainfall to Christian, Jewish, Mohammedan or Mormon prayers in various lands? The states of Washington and Oregon (west of the Cascades) have more rain than has the state of California (west of the Sierras). Is this difference due to the wickedness of Hollywood, and the past generation of gold diggers, and the holiness of the lumberjack? The adherents of the supernatural pray and irrigate the arid lands; others merely irrigate. The crops seem to parallel the irrigation rather than the prayers. Were it not for supernatural tabus, many other supernatural claims could be put to the experimental test. It should not be much more difficult to determine the efficacy of prayer against such diseases as syphilis, malaria, diabetes and goiter, than to establish the merits of arsenic, quinine, insulin and iodine. Not very long ago I read a signed public statement by a lady in the state of Kansas to the effect that she had seen a goiter melt away from the neck of another lady during the praying of the Reverend Aimee Semple McPherson directed toward this end. This appears like direct evidence. But metabolism tests, neck measurements and motion pictures of the "melting" process would go further to convince the skeptics. What people under intense emotions and desire to believe think they see has frequently no relation to the light that actually impinges on the retina. Intense faith as well as intense fear seem to predispose to hallucinations in many people.

The moral efficacy of infant and adult baptism could also be tested experimentally, although with less accuracy, until better quantitative measures of human character are worked out. A prominent physiologist told me he had done this experiment in his own family, having two of his children baptized, and keeping the other two children as controls. I will not even mention the results, for we draw no conclusion from so few experiments, but it might be pointed out that identical twins would be the best material for this test. Is supernaturalism dead? Some Protes-

tant clergymen inform us that Jehovah is a prohibitionist, and the people who oppose our present prohibition of alcoholic beverages are fighting God. Some of the Roman Catholics tell us that raising grapes and drinking wine is God's plan for man. Such confusion on the celestial lines of communication ought to provoke thought. It seems to induce nothing but reciprocal anger.

Many people take the position that science is well and good in the "material" world. They would exclude the method and attitude of science from certain fields of human life. A prominent New York rabbi said only a few days ago: "Human feelings and emotions will remain outside the scope of science forever." As if the biological sciences, including medicine, have not already produced a very respectable body of verifiable data on the mechanisms of the emotions. The relation of the brain to the emotions is nearly as clear as the relations of the kidneys to the secretion of urine or the relation of the gullet to swallowing. That complete obstruction of the gullet will prevent swallowing I do not think would be denied even by a rabbi. It is a favorite saying that there is more than science in the universe and in human life. We grant that. At the present the unknown exceeds the known. There is more ignorance than science. But is that a cause for exultation? Instead of wasting time and energy in the futile effort of building fences around science, and in a meticulous labeling of the "unknowable," we had better join hands in tackling the unknown, not with worship, prayer or propitiation, but with the tool of science. Here is useful and joyful work for everybody.

The Ethics of the Supernatural

May I make a few concluding remarks on the ethics of the supernatural, speaking not as a scientist but as a common man? The ethics of science is simple: absolute honesty in recording and presenting data, and curbing wishes, personal prejudices and emotions by reason in interpreting the data.

There appears to be a great variety of ethics in the supernatural. Looking upon the supernatural simply as man's early stumbling attempts at learning, at adjustment, as flounderings toward greater happiness, as quests for explanations of the unknown, this variety is both inevitable and understandable. From this point of view, the modern man of science has no essential quarrels with Jesus, Confucius, Zoroaster, or Buddha. They did the best they could, considering the ignorance of their times. We can do no more. But now and then individual champions of the supernatural have been either unusually stupid or inordinately selfish and cruel. The judgment of posterity will be severe on the men who coerced Galileo and their brethren of to-day who know or might know, yet rivet the shackles of supernaturalism on the human mind. For they sin against man. It is significant that neither Jesus nor his apostles appear to have claimed any supernatural authority or absolute wisdom for their sayings or writings. The ignoble doctrine of divine revelation of absolute truth for all times appears to be a later invention. But in Mormonism and Mohammedanism it is present with the founders. I said: ignoble doctrine. Intellectual tyranny is to me as immoral as physical tyranny. Stifling freedom of inquiry and of thinking by religious tabus or legal dicta appears to me highly immoral.

The view or belief that some one man or group of men (such as Brahmins, popes, priests, etc.), above all other humans, is specially endowed or enlightened to perpetuate and advance truth, and mediate between gods and man favors tyranny. It seems inimical to knowledge and human dignity, hence immoral.

The supernatural theories of "sin," personified evil, redemption, eternal damnation, etc., when actually believed, have created and are creating much disturbance in man's emotional life, in the way of fear, worry, melancholy, if not outright insanity. The theory or doctrine of the vicarious atonement in the Christian religion is not only a projection of views and practices of barbarism into modern life, but it connotes a principle of punishment and propitiation at variance with modern sense of justice. It goes without saying that many Christian people are not aware of this.

If we take a look at the gods, they can be understood and condoned as inventions of man, at varying stages of social development. The fossilization of nearly all so-called sacred books by edicts and tradition has brought about the anomalous condition that the best people in many religions to-day are ethically superior to their gods. In the recent invasion of Palestine the modern Israelites have shown themselves in treatment of the Arabs, by and large, superior to Jehovah of the Bible.

If man as well as his social environment remained stationary, static mores might serve very well. But social, economic and political life appears to be more fluid than man. Hence the necessity of continuous amendment of the mores. For example, the travail of modern life is forcing the practice of birth control into the open for a more rational and humane settlement, despite the thunders from Mount Sinai and the echoes thereof from the Vatican Hill. If a physiologist, in 1930, may venture to reinterpret the aphorism of Paul, anent faith, hope and charity, it would read something like this: Faith is of the past, hope must be chastened by experience, charity in mod-

ern garb, is misdirected benevolence. But there remains the endeavor towards understanding, the hunger for beauty, the urge for justice—these three, and the greatest of the three is justice.

Science nurtures inquiry, the supernatural stifles it. The two are in their very essence incompatible, but they can apparently coexist in some scientists of the first rank. Man is, indeed, a perplexing animal. He is rarely consistently consistent or consistently inconsistent. The crook is not always crooked, the murderer not always cruel, the thief not always greedy. An honorable person may lie and a liar sometimes tells the truth. A shrewd business man may consult a soothsayer and be afraid of a black cat. Most men in early childhood are emotionally conditioned to the supernatural, just as they become emotionally conditioned to other elements of childhood environment: parents, places, playmates, nursery rhymes, the old swimming hole, and what not. Retaining and recalling these emotions please us. Adults may be conditioned, but usually with less emotional content than the child. We can be conditioned to science or justice just as to the supernatural, but the latter usually gets there first. The conditioned emotions usually outlive one's intellectual metamorphosis. Their disappearance seems to be a slow atrophy of disuse. Many factors appear to enter into the persistence of early conditioning to the supernatural, such as group loyalty, the desire to conform to social usage, the disinclination to disturb or distress parents and other intimate friends; social, political and financial ambitions, etc. Men also appear to differ in the emotional satisfaction obtained from the mystic. Additional factors, such as individual emotional capacity, may be operative in making some scientists think and work, while others think and work and pray. I admit it may be easier for men in the physical sciences than for biologists to cling to the supernatural, for much of the grotesque in the supernatural concerns man and other living things rather than inanimate nature. But even so, it is a fact that Rev. Stephen Hale laid the foundation for the science of hemodynamics, and Friar Mendel discovered fundamental principles in heredity. So far as I know, the Reverend Hale and Friar Mendel were sincere adherents of their respective religious cults. Our social heritage, good, bad and indifferent, clings to us like the hand and the appendix of organic inheritance. Hence, like the proverbial Englishman, we "muddle" but, now and then, we "muddle through." Fear and faith have ruled much of man's past, but the millennium is still far, far away. Now let us try what may be accomplished by undertaking. Give science a chance.

I seem to sense a silent sigh from you, saying: "Thank God, he is through." I am—nearly. Knowing next to nothing about public speaking I consulted an experienced colleague, before preparing this talk. He referred me to a well-known canon, which reads: First, you tell your audience what you intend to tell, then you proceed to tell it, and lastly you tell what you have just told. You may have observed that I have followed this advice. I have now reached the lastly. Lest I be accused of hiding my real views in a plethora of verbiage, I will attempt to sum up, in threescore words, what I tried to say in seven thousand: As I see it, the supernatural has no support in science, it is incompatible with science, it is frequently an active foe of science. It is unnecessary for the good life. And yet, the supernatural, in varying dilutions, is likely to persist in society for a very long time. The unconditioning and reconditioning of mankind in fundamentals has been a slow process in the past. It may go a little faster in the future. It is a matter of forgetting the hypothetical universe created out of ignorance and motivated by our undisciplined emotions; and a reconditioning to the actual universe, as gradually understood through controlled experience and experiment.

COPE: MASTER NATURALIST[1]

By Dr. HENRY FAIRFIELD OSBORN

PRESIDENT OF THE AMERICAN MUSEUM OF NATURAL HISTORY

AMERICA is slow to recognize her own great men. Along the entablatures of our scientific buildings as well as of our public libraries are enrolled all the greater names in the long intellectual history of man beginning with the Greeks, but these tributes stop short when it comes to the enrolment of great Americans. We have shown so little appreciation of the life of the subject of this volume that his name is not even mentioned in the recent encyclopaedias which contain many lesser American names. In this case it is not difficult to find at least a partial explanation. Cope was never on the side of the great powers of the period either in science or in government, for both

[1] Foreword of a volume soon to appear from the Princeton University Press entitled "Cope: Master Naturalist, the Life and Letters of Edward Drinker Cope," text 590 pages, classified bibliography of 150 pages and 1395 titles, by Henry Fairfield Osborn, assisted by Helen Ann Warren as editor and co-author. The volume is a sequel to the author's "Biographical Memoir of Edward Drinker Cope, 1840–1897," published by the National Academy of Sciences in 1930.

in intellectual equipment and in life history there is a strong parallel between Cope and his great French Revolutionary predecessor, Lamarck. Both were men of genius; both were innovators in the classification of the animal kingdom; both rendered great service to the science of zoology; both failed of contemporary scientific and political support; both ended their lives in poverty and more or less obscurity. May the publication of this volume have at least one great result, namely, that posthumous justice be done to Cope as it has been done to Lamarck, and that his name be enrolled as one of the master naturalists of all time.

The preparation of this volume has been a labor of love, practically beginning a month or so before Cope's death in the year 1897 with my insistence that he should begin to prepare his own bibliography. During the thirty-three succeeding years step after step has been taken in the preparation of this volume, aided by many willing and able coadjutors both in the extremely arduous preparation of a bibliography of such length and complexity as has never been known before and in the no less arduous preparation of the biography which began with many contributions from Cope's contemporaries in the year 1897. It reached this final phase by close, continuous and active work on the part of a recent graduate of Barnard College, Helen Ann Warren, an excellent exponent of the advantages of the higher education of women, so strongly advocated by Cope, and a graduate of an institution endeared to the present author by the lifelong devotion of Lucretia Perry Osborn to its interests.

Soon after Cope's death his beloved daughter, Julia Cope Collins, whose name figures largely throughout his correspondence, presented to the American Museum Cope's complete personal library of his own publications. This furnished the backbone of the bibliography. A greater mark of confidence was the deposit in the American Museum of the lifelong correspondence of Cope with his family, including intimate letters which throw an entirely new light on his personality. The first duty of Miss Warren was to copy these letters from the beginning to the end, thereby creating a picture of Cope's whole life story. The letters were written in brilliant style; they form a priceless picture of the United States in the Civil and post-Civil War period. They allude to the trials and hardships as well as the ambitious and rivalries inevitable in the pioneer western period in which Cope was working. While many strictly family references have been omitted from the letters in Chapters II to VI and such omissions are partly indicated by dots, a great many matters including Cope's high or low opinions of other men and defenses of his own lines of conduct are included. The omission of some of these passages perhaps might have placed Cope in a more angelic light. On the other hand, such omissions would not have given a true biography, so, with the full permission of Cope's family, they are included. We feel confident that the true light on personality is always the best light and that many who have hitherto misunderstood the character of Cope will be more charitable in their judgments and more full of admiration for the many fine sides of his character. Another reason for extensive quotation of the letters is that the family have lent very substantial aid in the preparation of this volume and will naturally welcome and enjoy the family side of Cope's life history.

Now that the hard thirty-three years' work in the preparation of this volume is drawing to a close, the author desires to express his heartfelt appreciation of all those who have cooperated in bringing it to completion. Their names are partly recited above and again in full throughout this volume. They are given fullest credit at every appropriate point throughout the work and are included in the following list of biographers and bibliographers:

Biography

Theodore Gill, 1897
Persifor Frazer, 1897
Julia Cope Collins, 1897–1931
William H. Collins, 1926
William Berryman Scott, 1897–1931, Geology and Paleontology
William Diller Matthew, 1897–1930, Paleontology
George Gaylord Simpson, 1929–1930, Paleontology
William King Gregory, 1930–1931, Ichthyology and Phylogeny
E. W. Gudger, 1930–1931, Ichthyology
G. Kingsley Noble, 1930, Herpetology
Barnum Brown, 1930, Paleontology
Frederic A. Lucas, 1928, Paleontology
Charles C. Mook, Geology
George Gaylord Simpson, 1929, Map of Cope's Journeys
John Germann, 1929–1930, Map of Cope's Journeys
Florence Milligan, 1925
Johanna Kroeber Mosenthal, 1913

Bibliography

Anna M. Brown, 1897–1899
Jannette May Lucas, 1915–1931
E. W. Gudger, 1924–1931
G. Kingsley Noble, 1920–1931
Robert T. Hatt, 1931
Barnum Brown, 1931
George Gaylord Simpson, 1930
Walter Granger, 1930
W. B. Veazie, 1917–1921
Paul Brockett, 1929–1930
William Diller Matthew, 1897–1930

Financial Aid

Julia Cope Collins
Mrs. Philip C. Garrett
The Cope Family
Henry Fairfield Osborn
The American Museum of Natural History

The work of my co-author and editor, Miss Helen Ann Warren, should be especially praised not only for its thoroughness and accuracy but for the rare quality of sustained interest and enthusiasm for the subject shown, especially in the introductory chapter entitled "Pioneers of Paleontology in America" which is very largely her own assemblage and writing, guided, of course, by the author, also in the biographic narrative of Chapter II which from the standpoint of the newer education seems the most opportune in this biography. The old education seems to have been altogether ideal in the case of Cope. Then we pass to Cope's experience in the university of the world and find him fully equipped for his great career.

I am confident that all who have taken part in the preparation of this volume will feel fully rewarded by the thought that they have helped to write a great chapter in the history of American science, namely, of a period covering the lives and labors of our three founders of vertebrate paleontology, Leidy, Marsh and Cope, a branch of science in which America has won a place of honor and esteem throughout the world. I trust also that this volume will firmly establish the permanent reputation of Edward Drinker Cope as a "Master Naturalist."

SCIENTIFIC EVENTS

THE BALTIC GEODETIC COMMISSION

THE Baltic Geodetic Commission is an organization for dealing with the geodetic problems of the many nations surrounding the Baltic Sea. It recognizes the fact that geodesy is no respecter of national frontiers. The nine member countries are Denmark, Esthonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. The fifth conference of the commission was held in Copenhagen last October. The member nations, except Russia, were all represented by accredited delegates, and in addition Norway and Austria were represented by invited guests. Six sessions were held for the consideration of business matters and reports; scientific papers were also presented and visits made to scientific institutions in and near Copenhagen.

The Baltic Commission has already gained a high reputation for the careful geodetic work done under its auspices and for its high scientific standards. The comparatively small number of its members, their nearness to one another and the frequency of the meetings all contribute to the close cooperation and to the interchange of experience that are so favorable to good work and rapid progress.

The commission is, however, considering the widening of its field of work. According to the convention establishing the commission any country desiring to join the commission is entitled to do so. At the Copenhagen meeting, moreover, there was some discussion of a very ambitious project that far transcends the geodetic survey of the Baltic area, namely, the extension of the existing geodetic arc along the 52nd parallel in Europe into Asia as far as Bering Strait and thence across the strait into Alaska, where it would connect with Alaskan triangulation, which in turn will soon be connected with geodetic triangulation in Canada. In this way the longest geodetic arc in the world would be formed. This would be a great achievement, but it will probably be some time before such a scheme can be carried out. Even the existing portion of the arc in Europe needs to be strengthened in various ways and it is still to be proved that it is feasible to make an adequate geodetic connection across Bering Strait.

Professor Kohlschütter, of Potsdam, was elected president, succeeding Professor Nörlund, of Copenhagen, who was chosen vice-president. Professor Bonsdorff, of Helsinki, continues to serve as general secretary.

The information on which this notice is based was supplied in part by Professor Schumann, of Vienna, who attended the meeting as a guest and representative of Austria.

W. D. L.

THE INTERNATIONAL BIOLOGICAL CONGRESS AT MONTEVIDEO

FROM October 8 to 12 there was held at Montevideo a Biological Congress as one of the events designed to celebrate the centenary of Uruguayan independence. A Medical Congress ran concurrently. The national government assisted those in charge by providing honoraria for a number of foreign delegates. Among these were Professor Gustav Embden, of Frankfort; Professor Pedro Rondoni, of Milan; Professor Claude Regaud and A. Mawas, of Paris; Professor Wolfgang Koehler, of Berlin, and Professor Edwin Baur, of Munich. Each South American country sent delegates representing its institutions. There were probably 200 in attendance. Plenary sessions were held each morning. The afternoons were devoted to visits to laboratories, museums and other institutions of local significance, while the evenings were used for sectional

meetings. Addresses were given at the plenary sessions by foreign delegates and other invited members. The sections represented were (1) general biology; (2) cytology, histology, embryology and anatomy; (3) physiology and biochemistry; (4) parasitology, microbiology, hematology and serology; (5) methods and didactics of the biological sciences. The general interest of South American biologists is probably well indicated by the names of the sections and by the numbers of papers given in each. At the plenary sessions 30 papers were presented; in section 1, 26 papers; section 2, 63; section 3, 101; section 4, 93; section 5, 9. Supplementary programs added 22 papers, making a total of 344. The strong medical cast of biology here is apparent in these figures and in the absence of such categories as genetics, ecology, etc.

The officers of the congress were: *President,* Clemente Estable; *Secretary,* Benigno Varela Fuentes; *Treasurer,* Julio E. Moreau. Additional members of the *Executive Committee* were Drs. Apolo, Cordero, Prunell, Pucci, Guerrero and Rubino. For each country in South America represented there was an executive committee and the membership in these is an index to the working forces in biology there. The largest foreign attendance was naturally from Argentina and Brazil. This first Biological Congress was so successful that it was voted to hold a second in Rio de Janeiro two years hence under the presidency of Professor Miguel Ozorio de Almeida. Attendance of North American biologists would, I am sure, bring them much pleasure and considerable surprise at the amount and character of biological work being done south of the Caribbean.

C. E. McCLUNG

LECTURES OF THE PHILADELPHIA ACADEMY OF NATURAL SCIENCES

THE Ludwick free lectures were given in the auditorium of the Philadelphia Academy of Natural Sciences during January and February and will continue through March. These consist of twelve Monday evening and eight Sunday afternoon lectures, the speakers and their subjects being as follows:

Francis R. Cope, Jr., "New Zealand for the Nature Lover."

Dr. Clyde Fisher, of the American Museum of Natural History, New York, "Wild Flowers of Spring."

Dr. William E. Hughes, research associate, "Honolulu."

Dr. S. A. Barrett, director of the Milwaukee Public Museum, "Tamest Africa."

Captain James Sawders, of Pittsburgh, "The Wonderland of Mexico."

Barnum Brown, of the American Museum of Natural History, New York, "Searching for Prehistoric Life in Arizona."

Dr. Witmer Stone, vice-president, "Bird Life of the New Jersey Sea Coast, Past and Present."

Samuel G. Gordon, "Across South America and Africa."

James A. G. Rehn, secretary, "A Naturalist in Honduras."

Lester W. Strock, "By Pack Train Through the Canadian Mountains."

Henry W. Fowler, "A Glimpse of Maritime China and Japan."

Wharton Huber, "Across Canada to the Queen Charlotte Islands."

The Sunday afternoon lectures were as follows:

Dr. Henry A. Pilsbry, curator of mollusks and marine invertebrates, "Shell Fish and Other Invertebrates of the Seashore of New Jersey."

James A. G. Rehn, associate curator of entomology, "Insects—Beauties and Pests Found Near Philadelphia."

Henry W. Fowler, associate curator of vertebrate zoology, "Fishes, Their Life in the Waters Around Philadelphia."

Dr. Emmett R. Dunn, of Haverford College, "Reptiles and Amphibians, Modern Relatives of Ancient Races."

Dr. Witmer Stone, curator of vertebrate zoology, "Bird Life in Springtime."

J. Fletcher Street, "Wild Flowers of the Philadelphia Region."

Wharton Huber, associate curator of vertebrate zoology, "Familiar Mammals of Pennsylvania and New Jersey."

Dr. Henry A. Pilsbry, "Animals of the Ancient Past."

The Monday evening lectures begin at 8 o'clock and the Sunday afternoon lectures at 3 o'clock.

THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

THE Federation of American Societies for Experimental Biology formed by the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology, will meet at the McGill University, Montreal, Canada, from April 8 to 11, 1931. The preliminary program follows:

Wednesday, April 8.—The members are invited to visit various laboratories and points of interest in Montreal. Meetings of the Executive Committee of the Federation and of the Councils of the Societies.

Thursday, April 9.—Joint Session of the Federation and Scientific and Business Sessions of the Societies. A complimentary banquet will be tendered the members in the evening.

Friday, April 10.—Scientific and Business Sessions of the Societies. Joint Demonstrations 2:00 P. M. General Meeting of the American Society of Biological Chemists at 3:30 P. M. The annual banquet

of the federation will be held at the Mount Royal Hotel at 8:00 P. M.

Saturday, April 11.—Scientific Sessions of the Societies. Joint Session of the Federation. A detailed program will be mailed from the office of the secretary of the federation.

The headquarters are the Mount Royal Hotel, Peel Street. A special registration and information bureau will be located on the ninth floor, and also a railroad ticket office, where certificates can be validated and where tickets can be purchased. All members should register at the bureau as soon as possible after arrival and should deposit their railroad certificates for validation. The Mount Royal Hotel can probably accommodate all members who attend. It offers a flat rate of three dollars per person. Requests for reservations should be directed to the Mount Royal Hotel, Peel Street, Montreal. Information in regard to other hotels can be obtained from the secretary. On each day of the meetings table d'hote luncheons will be served at the Mount Royal Hotel at a price of one dollar per person.

A reduced fare on the "Certificate Plan" of one and one half fares for round trip to and from Montreal will apply to members and associate members (and their dependent families) of the Federation of American Societies for Experimental Biology and affiliated societies, provided over 150 members present certificates.

The local committee in charge of arrangements consists of Drs. J. B. Collip, *chairman;* B. Babkin, N. Giblin, F. E. Lloyd, C. N. H. Long, J. C. Meakins, E. G. D. Murray, H. Oertel, R. L. Stehle, John Tait, D. L. Thomson, T. R. Waugh and D. R. Webster. Arrangements for demonstrations are in the hands of Dr. John Tait, physiology; Dr. D. L. Thomson, biochemistry; Dr. R. L. Stehle, pharmacology, and Dr. T. R. Waugh, pathology.

Any requests should be addressed to Dr. J. B. Collip, chairman of the Local Committee.

HOWARD B. LEWIS, *Secretary,*
University of Michigan,
Medical School,
Ann Arbor, Michigan

THE PASADENA MEETING OF THE AMERICAN ASSOCIATION AND THE ASSOCIATED SOCIETIES

PLANS for the first regular summer meeting of the American Association for the Advancement of Science, to be held at Pasadena, California, from Monday, June 15, to the following Saturday, are rapidly taking shape. The California Institute of Technology, Mount Wilson Observatory and the Huntington Library and Art Gallery are hosts for this meeting and are cooperating with the Los Angeles Chamber of Commerce and the American Association for the Advancement of Science to make it exceptionally large and successful in every way. Arrangements for the meeting are in the hands of a local committee composed of Paul W. Merrill, *chairman,* Harold D. Babcock, *secretary,* John P. Buwalda, E. C. Watson, Linus Pauling and R. O. Schad.

A group of men of national and international reputation will deliver a series of six evening lectures during the meeting. The list of invited speakers includes outstanding authorities in their particular fields of research. It appears that all sections of the association will be represented in the program. Section B (Physics) and the American Physical Society are planning a four-day meeting. A program committee in charge of physics has already taken active steps and has supplied an impressive list of prominent European physicists who expect to be in California this summer.

Other national societies which are planning to meet with the association are: the Illuminating Engineering Society, the American Association of Economic Entomologists (Pacific Slope Branch), the American Chemical Society (Pacific Intersectional Division), the American Meteorological Society, the American Physical Society, the American Phytopathological Society (Pacific Division), the Astronomical Society of the Pacific, the Botanical Society of America (Pacific Section), the Ecological Society of America, the Society of American Bacteriologists, the Society for Experimental Biology and Medicine (Pacific Coast Branch), and the American Society of Plant Physiologists. The following local organizations are also planning to hold sessions: California State Veterinary Medical Association, the Cooper Ornithological Club (Northern Section and Southern Section), the Lorquin Entomological Society, the Pacific Coast Entomological Society, the San Francisco Aquarium Society and the Western Society of Naturalists.

It is hoped that the morning sessions only will be devoted to the reading of papers by the associated societies and sections and that the afternoons will be devoted to excursions to near-by points of interest. Low excursion rates from nearly all parts of the United States will be available.

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the National Academy of Sciences will be held in the building of the academy in Washington from April 27 to 29 under the presidency of Professor T. H. Morgan, of the California Institute of Technology. The four-year term of the officers expires at the meeting. Professor A. A. Michelson and Professor William H. Welch are the only living former presidents of the academy.

THE executive committee of the American Association for the Advancement of Science will meet in Washington on April 26. Business relating to the Pasadena and New Orleans meetings or other activities of the association should be communicated to the permanent secretary in the building of the Smithsonian Institution, Washington, D. C.

THE Franklin Medal for 1931 will be conferred on Sir James Hopwood Jeans, secretary of the Royal Society from 1919 to 1929, and on Dr. Willis R. Whitney, director of the Research Laboratory of the General Electric Company at Schenectady, New York. The medals will be presented at the institute's Medal Day exercises on May 20.

THE Astronomical Society of the Pacific has awarded its Catherine Wolfe Bruce Gold Medal "for distinguished services to astronomy" to Dr. Willem de Sitter, director of the Observatory at Leiden, Holland.

THE council of the British Institution of Electrical Engineers has made the tenth award of the Faraday Medal to Mr. Charles H. Merz, consulting engineer and senior partner of Merz and McLellan. The Faraday Medal is awarded not more frequently than once a year either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence, or membership of the institution.

THE Dalton Medal of the Manchester Literary and Philosophical Society has been awarded to Sir J. J. Thomson. The presentation will be made on the occasion of the delivery of the Dalton Lecture before the society on March 17.

SIR D'ARCY POWER, who has returned to England from lecturing in America, has been presented with a volume of selected writings from his own work in commemoration of his seventy-fifth birthday. The presentation was made at Sir D'Arcy's hospital, St. Bartholomew's, by Lord Moynihan, who described him as the most eminent medical historian of our day.

DR. P. COPANARIS, director of hygiene of the Republic of Greece, was tendered a banquet by the city of Savannah, Georgia, on February 3. Dr. Copanaris has been visiting health departments in America as the guest of the International Health Division of the Rockefeller Foundation.

Nature writes as follows: "The University of St. Andrews has sent its congratulations to Dr. W. W. Keen, of Philadelphia, one of its honorary graduates, on his attainment, on January 19, of the age of ninety-four years. It is twenty-three years since Dr. Keen resigned the professorship of surgery at Jefferson Medical College. The honorary degree of LL.D. was conferred upon him by the University of St. Andrews in 1911, during the celebration of the five-hundredth anniversary of the foundation of the university. Dr. Keen's longevity and cheerful hardihood are matched by those of Emeritus Professor W. C. M'Intosh, also of St. Andrews, who is ninety-two years of age and is still busy with scientific work."

AT the recent meeting of the Georgia Academy of Sciences, Mr. R. D. Kneale, industrial engineer at Atlanta, Georgia, was elected *president;* Dr. Alfred W. Scott, head of the department of chemistry of the University of Georgia, *vice-president;* Dr. George H. Boyd, head of the department of zoology, University of Georgia, is *secretary-treasurer.* Dr. Karl K. Darrow, of the Bell Laboratories of the American Telephone and Telegraph Company, made the principal address. He spoke on "X-Rays and Electricity as Waves." The membership was raised from 60 to 70.

MR. ROBERT E. TALLY, vice-president and general manager of the United Verde Copper Company, has been elected president of the American Institute of Mining and Metallurgical Engineers at the recent New York City meeting. Mr. H. A. Guess, of the American Smelting and Refining Company, and Mr. Howard N. Eavenson, of Howard N. Eavenson and Associates, Pittsburgh, were elected vice-presidents.

AT the annual meeting of the Royal Microscopical Society, held on January 21, Professor R. Ruggles Gates was elected president.

THE first president of the Social Science Research Council, Dr. Edwin B. Wilson, professor of vital statistics in Harvard University, after serving for a year and a half, has been succeeded by Dr. Robert S. Woodworth, professor of psychology in Columbia University, who is expected to serve for a similar term, and who will continue to carry a part of his university work.

DR. FRED JENNER HODGES, lecturer in radiology in the University of Wisconsin Medical School, has been appointed professor of roentgenology at the University of Michigan, to succeed the late Dr. Preston M. Hickey.

THE corporation of the Polytechnic Institute of Brooklyn has reappointed Professor Vladimir Karapetoff, of Cornell University, as visiting professor of electrical engineering for part-time service at the Polytechnic for the year 1931–1932 and has given permanent appointment as research professor of electrical engineering to Dr. Ernst Weber, of the Technische Hochschule of Charlottenburg-Berlin, who is at the Polytechnic Institute this year as visiting

professor of electrical engineering. Both Professor Karapetoff and Professor Weber will devote their efforts to the development of graduate evening study and the encouragement of research activities in the field of electricity.

MR. CONRAD L. WIRTH has been appointed assistant director of the National Park Service in charge of the branch of lands to succeed the late Mr. W. B. Lewis.

FOR the purpose of advising the British Minister of Health on the practical application of modern advances in the knowledge of nutrition, an advisory committee has been appointed comprising the following members: Professor Major Greenwood, *chairman;* Professor E. P. Cathcart, Sir F. Gowland Hopkins, Miss Jessie Lindsay, Professor E. Mellanby and Professor V. H. Mottram. The members will hold office until December 31, 1933, and will be eligible for reappointment. The secretary to the committee will be Mr. F. R. Hudson, of the Ministry of Health.

DR. R. R. WOOLEY, second-year fellow in astronomy at the California Institute of Technology, has been appointed to an Isaac Newton Scholarship in astronomy at the University of Cambridge, and will continue his studies there next year.

MR. STANLEY F. MORSE, consulting agricultural engineer of South Carolina and New York City, who is making a business trip and studying agricultural economic conditions in England, France, Spain and Italy, has completed an inspection and report of a 150,000-acre irrigation project in southern Spain.

DR. M. A. JOSLYN, research assistant in fruit products, University of California College of Agriculture, has been given leave of absence for six months to aid in the inauguration of a plant for the production of frozen orange juice in Florida.

A COURSE of lectures on Photographic Theory at the Institute of Applied Optics, Rochester, New York, is being given by Dr. C. E. K. Mees, Dr. K. C. D. Hickman, Dr. E. P. Wightman, Mr. J. I. Crabtree and Mr. L. A. Jones. The lectures are given on consecutive Fridays. They began on February 6. In addition to the lectures listed, a laboratory course has been arranged by Mr. Russell and Mr. Westwater, of the Kodak Park Laboratories.

DR. ARNOLD K. BALLS, lecturer in biochemistry at the University of Prague, lectured recently on "Recent Advances in Enzyme Chemistry" at Columbia University, the Rockefeller Institute, the University of Pennsylvania and the Pennsylvania State College.

PROFESSOR ALFRED C. REDFIELD, of the department of physiology of the Harvard Medical School, has accepted appointment to lecture in March at the Belgian universities under the auspices of the C. R. B. Educational Foundation. Professor Redfield will lecture in French on "Some Aspects of the Problem of the Evolution of the Respiratory Function of the Blood," and in English on "The Equilibrium between Oxygen and Hemocyanin."

AT the request of M. Briand, the minister of foreign affairs, who desires to promote the international exchange of university professors, the French minister of public instruction requested the council of the Faculté de Paris to designate an eminent professor who would be invited to lecture at the University of Paris. Accordingly Professor Jadassohn, of Germany, delivered three lectures on dermatosyphilography.

THE forty-sixth meeting of the American Astronomical Society, on the invitation of Professor Harlan True Stetson, will be held at the Perkins Observatory, Ohio Wesleyan University, Delaware, Ohio, on September 7, 8 and 9.

THE annual meeting of the American Society of Zoologists for 1931 will be held in New Orleans, La., December 29 to 31, inclusive, in affiliation with the American Association for the Advancement of Science. Joint sessions with closely related societies will again be features of the meeting.

A SOIL FERTILITY CONFERENCE commemorating the fiftieth anniversary of the soil fertility plots at the Pennsylvania State College will be held on June 24, 25 and 26. The college and experiment station staff, assisted by eminent soil technologists of other institutions, will present a technical program based on many detailed studies of these old plots. There will be two half days devoted to technical papers, two half days to excursions over the plots, college farms and outlying soil fertility projects, and one half day to an open forum on soil fertility problems. Special inspection trips to the orchard and gardens will be arranged. Dr. W. H. Jordan, who laid out these old plots fifty years ago, will be the guest of honor and will give an address. An official program will be issued three months in advance of the conference. Invitations will also be sent to all the Land Grant Colleges, the U. S. Department of Agriculture and to other research agencies, including many prominent soil technologists in the United States, Canada and European countries. The conference will not be limited to invitation; a cordial welcome is extended to all those interested.

Industrial and Engineering Chemistry reports that the opening of the Oscar Johnson Institute in St. Louis in January has made available facilities for research in diseases of the eye, ear, nose and throat. The institute, founded in memory of the late Oscar

Johnson, shoe manufacturer, was completed at a cost of $1,500,000, including equipment. The staff includes specialists in physics, physical chemistry and bio-chemistry, bacteriology and immunology, physiology, anatomy and pathology. The facilities of the institute will be at the disposal of any research worker who has a significant problem and the personal equipment to attack it. Research and teaching are endowed by the General Education Board. In addition, specific investigations of chronic and progressive deafness and an exhaustive program of trachoma research are being financed.

THE trustees of Battelle Memorial Institute, Columbus, Ohio, have announced the establishment at the institute of a research project sponsored by the Calumet & Hecla Consolidated Copper Company, of Calumet, Michigan. The purpose of this project is to make a fundamental study of arsenical and argentiferous lake copper in respect to its properties and application to industrial uses. It has long been recognized that copper containing small amounts of arsenic and silver has definite well-defined advantages and recent developments have brought to mind the possibilities of further industrial applications. This research program is comprehensive in character and is in a most promising and fertile field. Mr. G. L. Craig has been added to the staff for work on this project, which is under the direct supervision of Dr. H. W. Russell and Mr. J. L. Gregg. Mr. Craig was formerly research fellow with the U. S. Bureau of Mines and more recently metallurgist for the Fairmont Aluminum Company.

DR. N. P. COLWELL, secretary of the Council on Medical Education and Hospitals of the American Medical Association, has notified President E. Everett Cortright, of the Junior College of Connecticut, that that institution has been placed on the list of approved colleges of arts and sciences for the two years of pre-medical education prescribed by the association.

THE correspondent of the London *Times* at Riga writes under date of February 8, "The Soviet Press is making a charge of counter-revolution against Professor Karpinsky, the president of the Academy of Science of Leningrad. The basis of the charge is that he objected to the expulsion of the Academicians Platonoff, Tarle, Likhacheff and Liubavsky. The academy summoned an extraordinary meeting last Monday for the purpose of obtaining an explanation from Professor Karpinsky, who is 85 years old. He made a speech in which he expressed regret that the academy had become the mere servant of a single party and a single doctrine, and had lost the measure of freedom and independence it had formerly enjoyed. Everywhere else, he said, the word 'Academy' signified a collection of men with all sorts of religions, individual views and individual opinions, but the academy in Leningrad had lost its status and had become a mere department of the Communist Party. He demanded the restoration of 'freedom of conscience and freedom of opinion' for academicians and the removal from its statutes of the recently introduced Paragraph 19, which had been 'forced on the academy by the Soviet government,' and under which Platonoff and the others were expelled for alleged political untrustworthiness. According to the published report of the proceedings Professor Karpinsky stood alone. The majority present were silent, but several new 'Red' academicians spoke, rebuking their president for his contemptuous attitude towards the Communist Party and disloyalty to the government. The Leningrad *Pravda* declares that at last Professor Karpinsky has unmasked his counter-revolutionary face, and stands revealed as an enemy of the proletariat, and the mouthpiece of reactionary forces."

PATENTS assigned to the Ohio State University which are the outgrowth of researches made by the university should be dedicated to the public of the state, according to an opinion of the Attorney-General, Gilbert Bettman. The summary of the opinion, given to George W. Rightmire, president of the university, follows: "Where the Ohio State University becomes possessed of a patent by assignment from the nominal patentee, which patent is the outgrowth of researches made by the Engineering Experiment Station of the university, the said university, through its proper officials, should dedicate said patent to the public of the State of Ohio."

A NEW national forest, the Hiawatha, with a gross area of 270,071 acres in the heart of the Upper Peninsula of Michigan, comes into being by proclamation of President Hoover. This brings the total number of national forests up to 150, and the forest becomes part of the vast area of over 160,000,000 acres administered by the Forest Service. The 179,719 acres within the boundaries of the Hiawatha which remain in private ownership are to be acquired by purchase as rapidly as agreements are reached with the owners and funds are made available by Congress. Practically the entire area is covered with forest growth. Little virgin timber of large size is left, since most of the land was cut-over or culled many years ago. Fires have also ravaged much of it, so that at present the stand over large areas is aspen. The aspen growth, however, will make a good protective cover for young white pine and Norway pine, to which the land is adapted. The area has considerable recreational value, but there is little land of value for farming within its

boundaries. The boundaries of the Hiawatha National Forest take in an area extending about 18 miles from north to south and 24 miles from east to west. Headquarters for the new forest, formerly known as the Mackinac purchase unit, will remain at Munising, Michigan. Under Forest Service administration, the Hiawatha National Forest will be protected and developed for its timber growing, recreational and other public forest values.

DURING the Pennsylvania Farm Show held recently at Harrisburg, the Pennsylvania Topographic and Geologic Survey displayed a series of exhibits designed primarily to illustrate the value and use of a survey of this type to the layman. A number of topographic maps showed various physiographic types found in the state. Other maps portrayed the geology, soils and mineral resources of Pennsylvania. A series of wall charts illustrated the state's position as a producer of mineral wealth. Upon tables were exhibits including examples of publications by the survey, minerals common to the state, common rocks and minerals often mistaken for valuable ores, and building stones. By means of specimens and photographs attention was called to the development of limestone caves, the exploitation of which for the tourist trade is a growing industry. Another series of specimens illustrated how fossils form and how they may be used in the search for mineral wealth. Throughout the five days that the Farm Show was open, one or more members of the survey was present to explain further the exhibits to those interested. Of the quarter million people who attended, it is estimated that not less than 10,000 persons inspected the survey's displays.

Nature reports that the Society for Cultural Relations with Soviet Russia is considering the possibility of organizing in Great Britain a tour of scientific institutes in Soviet Russia during July and August, 1931. It is proposed to arrange for parties of British scientific workers engaged in physical, biological and medical research to visit and meet Russian workers engaged in similar researches. V.O.K.S., the central institution in Moscow for organizing cultural relations with foreign countries, is prepared to do everything possible to help the tour, and Intourist, the Soviet organization for tourist parties, will consider giving specially reduced traveling charges. Scientific workers desirous of joining such a tour are invited to write to the secretary, Society for Cultural Relations with Russia, 1 Montague Street, London, W.C.1.

THE dean of the Medical Faculty of the University of Vienna, Austria, has notified the American ministry at Vienna that American citizens who file application to become regular students in the medical department must have the degree of bachelor of science or bachelor of arts. In addition, prospective students must comply with the minimum American requirement; that is, twelve hours of chemistry, eight hours of biology and eight hours of physics. They must also take in Vienna a part of the examination in anatomy, histology and physiology.

THE Bureau of Standards reports that the supposed necessity for using large prisms and telescopes of large diameter when making accurate measurements on the index of refraction of optical glass has been investigated recently in the optical instruments section at the Bureau of Standards, and it was found that a 60 degree prism with edges measuring three eighths of an inch in length is sufficiently large for use with the most accurate apparatus now available. This work required a determination of the accuracy which is possible in pointing a telescope at a suitable target and also of the way in which this accuracy may vary as larger telescope lenses are used. Another matter depending on prism size is the error made in properly orienting the prism around a vertical axis when measuring its refractive properties. This difficulty is shown to be less important than has been generally supposed, and a satisfactory method of correcting for such small errors is suggested. It is concluded that large telescopes and special methods for correctly orienting the prism are unnecessary in the most accurate measurements of this kind. As a result, small prisms may be used with confidence when testing optical glass for those small but harmful variations in optical density which may be found within a sample intended for use in constructing an optical instrument of high precision.

THE Oxford University Exploration Club, in its annual report for 1929–30, as summarized in the London *Times*, states that the launching of the club in December, 1927, was due to the energy of two or three men who had a definite objective: they wished to organize an expedition to Greenland, which, through the active aid of various senior Oxford men, was carried through to a successful conclusion. Thus the club had an effective start, which has been followed up by further expeditions to British Guiana in 1929 and to Lapland in 1930. The undergraduate membership has increased to 26, most of whom are both willing and eager to work on an expedition. It is hoped that a continuous succession of undergraduate organizers will be maintained, in order that this enthusiasm may be directed towards definite objectives. At the same time there are a number of members every year who are unavoidably prevented by

schools or other difficulties from taking part in expeditions; also the possibilities of expeditions leaving England except in long vacation have so far been considered negligible. With this in view a group of members began in March to organize a hut scheme, in collaboration with the Oxford University Mountaineering Club; their object is to secure huts and bothies in various out-of-the-way places in the mountain groups and Great Britain and Ireland, which will serve as bases for walking and climbing. The first of these huts, under Craig-yr-ysfa, in Cwm Eigiau, has now been put into working order. With the annual report is given an account of the British Guiana expedition in 1929. The aim, it is stated, was not primarily to explore unknown territory, but to penetrate into the canopy of the tropical rain-forest, which offered the prospect of discovering a zone of life practically untouched by science. Publication of results has already begun, but will not be complete for some years, owing to the large number of species involved and the little that is known about them. It seems certain that more new species have been secured than by any previous Oxford expedition. The contributions to the general ecology of the rain-forest, to knowledge of territory and related problems in bird-life, to insect mimicry, to life-histories of wasps and bees, and to the elucidation of the still obscure dominant species of trees are likely to be especially notable.

DISCUSSION

METEOR CRATER IS NOT A LIMESTONE SINK

IN SCIENCE, January 9, 1931, Mr. F. S. Dellenbaugh suggests that the great pit of Meteor Butte, in Arizona, is a sink formed by ground water solution in the Kaibab limestone. If this suggestion were addressed to geologists only, there would be no need for a reply. The geologic facts speak for themselves; they are not merely unfavorable to Mr. Dellenbaugh's idea—they disprove it conclusively. Inasmuch as his article reached an audience made up in large part of non-geologists, a brief statement of the geologic evidence is in order.

Mr. Dellenbaugh is correct in saying that the Kaibab limestone contains many sinks, which receive much of the surface drainage on the Kaibab Plateau. These sinks, however, and especially those of large size, are located on wide flats or on the floors of large shallow basins, where they receive considerable run-off. Solution of limestone is a slow process, and its accomplishment on a large scale requires a large quantity of water. It would be a wonder indeed to find in a semiarid country a sink, almost circular in plan and nearly a mile in diameter, occupying the entire top of a hill, where the only water available for solution consists of the scanty rain that falls directly on the area of the pit. For Meteor Butte is a hill, as its name implies. On all sides the ground slopes away from the very edge of the circular rim, and hence no outside drainage can enter the central depression. From this general consideration alone a geologist would be very skeptical of the sink hypothesis for this feature. The following points are sufficient to remove the hypothesis from further consideration.

(1) A limestone sink does not reach deeper than the base of the soluble formation in which it is formed. This is a fact of observation, and is also an elementary deduction, since the material that once occupied the position of the sink had to be removed by solution. At Meteor Butte, however, the Kaibab limestone forms less than half the height of the walls. Beneath it is the Coconino sandstone, one of the most insoluble rock formations known, since it consists entirely of quartz grains cemented by silica. Any suggestion that this sandstone may have caved in owing to solution directly beneath it is ruled out, because the Coconino sandstone rests on red shales and sandstones many hundreds of feet in thickness.

(2) At the top of the great pit the slopes on all sides are littered with fragments of the Coconino sandstone. These fragments range in size from minute bits of broken sand grains to blocks of large size; and they are intimately mixed with similar débris derived from the Kaibab limestone. How were these pieces brought up from their normal position hundreds of feet below? Obviously by a great force that acted upward and was explosive in character, since it not only hurled the angular blocks in all directions but even smashed the individual sand grains to tiny bits. Examination of this pulverized quartz leads to the conviction that much more of the rock blown out to create the crater was blasted into dust, which mounted in a great cloud and drifted away to settle as a thin veneer on the wide surface of the plateau.

(3) Although the rock strata are practically horizontal beneath a wide surrounding area, in the walls of the crater these strata are tilted and otherwise disturbed. On the south side, where the wall is steepest, the beds dip directly into the wall, at a high angle. There is no haphazard arrangement, such as would be expected if the disturbance were due to slumping into a solution pit. The tilt is consistent in direction, and indicates that a powerful lifting force acted inside the pit, with concentrated action on the south side.

(4) In places the quartz sand in the Coconino sandstone forming the lower part of the walls has been fused to glass (lechatelierite). This is astonishing in view of the extremely high melting point of quartz (nearly 1500° Centigrade). Evidently the crater has been subjected to intense heat, such as could be generated only in some exceptional way. (See A. F. Rogers, "A Unique Occurrence of Lechatelierite or Silica Glass," *Am. Jour. Sci.*, vol. 19, 1930, pp. 195–202).

In brief, all the evidence indicates that a violent explosion played a prominent part in the formation of the crater. The weight of this evidence was appreciated by the earliest investigators, and naturally the idea of a gaseous volcanic eruption was given serious consideration. The abundance of meteoritic iron on and around the butte, however, has given strong support to the theory that the great pit was caused by impact of a close swarm of meteorites, and by an explosion after the swarm penetrated to considerable depth. Owing to the strength of this theory the butte acquired its present name.

Mr. Dellenbaugh sees support for his own hypothesis in the fact that both the inside and outside slopes of the crater show the effects of erosion. Whatever its origin, the crater has been outdoors since its formation, and modification of its slopes by erosion has been inevitable. This fate it shares with every other landscape feature.

Finally, Mr. Dellenbaugh "sees nothing . . . that substantiates in the slightest degree the meteor theory." If he has in mind the particular hypothesis that called forth his discussion—Professor Fairchild's suggestion of a stony meteorite—I quite agree with his view. Although Fairchild's idea has interest to a geologist, it appears to be wholly speculative, and creates difficulties more serious than those it purports to remove. There is strong observational evidence, however, in favor of the theory involving metallic meteorites. Some of this evidence is discussed by Mr. D. M. Barringer in SCIENCE for January 16, 1931. An excellent non-technical review of the facts about Meteor Butte, accompanied by fine illustrations, has been published by William D. Boutwell ("The Mysterious Tomb of a Giant Meteorite"; *National Geographic Magazine*, Vol. 53, 1928, pp. 720–730).

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BRANCHINECTA AT LEADVILLE, COLORADO

DURING the summers of 1929 and 1930, while engaged under the auspices of the United States Geological Survey in areal mapping and mine studies in Colorado, the writer found the phyllopod crustacean *Branchinecta coloradensis* (Packard) at 11,450 feet (3,500 meters) near Leadville, Colorado. The species has generally been regarded as alpine, and collections have been made nearby at Twin Lakes and Weston Pass in similarly elevated regions.[1] The occurrence is not surprising, but it raises again two perplexing questions.

In the upper part of Evans Amphitheater, due east about five miles from Leadville, are two larger lakes now serving as water reservoirs. Here is a well-developed recessional "kettle" moraine of late (?) Wisconsin glaciation. On the south side of the gulch near the reservoirs the moraine contains two small ponds, neither over 10 feet deep and both less than 100 feet wide. Both ponds, but the upper especially, are well separated from nearby water bodies. Indeed, it would require a valley flooding of at least a quarter of a square mile to a depth of 50 feet to connect the more isolated pool with a stream or with the reservoirs mentioned. Both pools are permanent, lasting throughout the short summer, but both are probably completely frozen during the winters at their elevation of 11,450 feet.

In these two pools the writer has found *B. coloradensis* during the past two summers. On July 18, 1929, *Branchinecta*, the females with brood pouches and eggs, were collected from the more easterly and isolated pond; by September 1, no live specimens were found, though a few remains of carapaces could be seen in the sediment. Again early in July, 1930, many *Branchinecta* were seen, the females again with eggs, this time in both pools; yet only a very few were in evidence by September 1. These observations are in general agreement with those of Shantz[2] near Pike's Peak, of Packard at Gray's Peak,[3] and of the latter especially in the case of related forms farther east,[4] where the disappearance is even earlier and is clearly not the result of lowered temperature. Shantz has suggested that the death of *Branchinecta* is related to parasitic plant forms, but the explanation does certainly not account for the Leadville records. It would seem that activity ceases in these Alpine species about September 1, and it would be interesting to develop an adequate explanation.

The other question is the unusual matter of "seeding" isolated ponds with *B. coloradensis*, or, for that matter, with other members of the family. The remarkable continuity of these phyllopods in a given pool, despite seasonal vicissitudes, is readily ex-

[1] A. S. Packard, U. S. Geol. Survey Ann. Rept. (Hayden), XII, Part I, 339, 1883; H. L. Shantz, *Biol. Bull.*, IX, 249, 1905; G. S. Dodds, U. of Colo. Studies, XI, 272, 1914–15; G. S. Dodds, U. S. Nat. Mus. Proc., LIV, 66–77, 1919.

[2] *Op. cit.*, pp. 256–258.

[3] *Op. cit.*, p. 339.

[4] *Op. cit.*, p. 342.

plained, but how did they come to their present habitat? Are we to assume that they represent a strain whose isolation dates back to glaciation, say, 10,000 years? If so, here is live material for the geneticist. Certainly a detailed study of their life history is merited.

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HEARING WITHOUT COCHLEA?

"THUS, even deaf persons whose eardrums no longer function properly, *but whose nerve centers are intact,* can hear radio."

By the distressed mother of a deafened child my attention was called to the above quotation from an article by Dr. Gustav Eichhorn in *Radio-Craft,* January, 1930, p. 330. "Thus" there means by the use of a patented device being essentially a membrane with one metal surface and one dielectric surface, which is held with its dielectric side close to the head. A telephone current passes to the metallized side of the membrane as to one condenser plate and to the human body (at any point) as if the body were the other condenser plate. The mother wanted to give her child this aid in hearing. There are many mothers like her.

The same matter is also described by the same author in the German periodical *Funk,* July 12, 1929, and still earlier in Jahrbuch f. drahtlose T. u. T., January, 1929. Since the eardrum, mentioned by the author, is no essential part of the auditory organ, I corresponded with him in order to know why he mentioned as the *exclusive* condition that "the nerve centers be intact." He was kind enough to reply that he had no definite opinion. Such a frequency of muscle function (6,000 and more per second) acting on the cochlea seemed to me unbelievable, and I felt inclined, therefore, to assume that we had here indeed a case of direct stimulation of the auditory nerve, especially since the author speaks of auditory perception of modulated currents by "Gehörlose," that is, the absolutely deaf. Those who can hear their muscle contractions are of course not Gehörlose.

If the auditory nerve could be used directly for hearing, that is, without the necessity of a mechanical function of the cochlea, this would be of tremendous importance for all those deaf people whose cochlea might be destroyed, but whose auditory nerve might be essentially intact. Dr. Eichhorn's description seemed to hint in this direction when it said that the electrical contact had to be made "gegen das Ohr oder an anderen Partien des Kopfes in der Nähe des akustischen Gehörzentrums," that is, "on the head in the neighborhood of the auditory braincenter."

I could not induce the author to send me one of his patented membranous devices. So I decided to experiment as well as I could. I used as source partly an oscillating electric system furnishing frequencies continuously between 50 and 20,000; partly amplified pick-ups of constant pitch phonograph tones of various frequencies. I removed the loud speaker, took one of the metal wires firmly in one hand, grasped the other wire end by its insulation and with its metal touched myself within the auditory meatus or behind the auricle; and to my astonishment in either case I heard faintly but clearly the very tone a moment ago produced acoustically by the loud speaker. After some experimentation I learned how to train others, many others, to perform the experiment with equal success, so that all possibility of "mere imagination" was excluded. It seemed to be true, then, that a new era of hope for the deaf had arrived, that the auditory nerve could be directly stimulated electrically and in agreement with the electrical frequency.

But after still more prolonged experimentation I now reject that hopeful conclusion. I shall mention three reasons why we must conclude that the hearing in question is due neither to direct action on the nerve nor to muscle contractions, but simply to a vibration of the horny skin surface caused by its electrostatic charge.

First, one does not hear anything when one touches the head with the wire end firmly. That is, there must be no electric conduction between the metal and the head. Nevertheless the metal must be held *close* to the skin for the sake of the electrostatic effect. This condition is realized by *gently rubbing* the wire over the skin, because then there is no real electric contact. As soon as one ceases to move the wire over the skin, the tone is gone, although that condition ought to be best for stimulating the nerve. I first thought that one might have to distinguish between an electrostatic and an electrokinetic stimulation of the nerve. But what would be the real difference?

Second, one hears more often the higher octave (that is, double frequency) than the actual cycle frequency. This is exactly what one should expect if the skin, statically charged by the neighboring wire end, is attracted and repulsed by the charge of the latter. A slight stretching of the skin is naturally advantageous.

Third, I succeeded in hearing the same tone when I rubbed the wire end gently over the slightly stretched skin of my wrist, holding the latter near enough, but not touching, one of my ears, nor touching any point of my head. The circuit then goes from one hand to the other hand by way of shoulder to shoulder. But there is no auditory nerve center

between the shoulders. Should one for an explanation fall back upon the distributed capacity of the whole body of which the nerve center is of course a part? This explanation is unlikely.

Thus the curious phenomenon of listening to the telephone wires without the telephone receiver resolves itself into nothing but a method of using the slightly stretched horny skin as an unusual kind of telephone receiver, an electrostatic receiver, a condenser receiver. One condenser plate is the skin, the other the wire end or still better wire loop; and the two acoustically vibrate toward each other. The cochlea still seems to be requisite for hearing. It's a pity so far as hope for the deaf is in question.

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COCCIDIOIDAL GRANULOMA

COCCIDIOIDAL granuloma is a disease of man and beast caused by Coccidioides immitis (Oidium coccidioides). The lesions may be in the skin, lungs and bones, and consist of granulomas and cold abscesses. The skin lesions are characterized by nodules and papulo-pustular eruptions. At times the lesion may resemble cutaneous tuberculosis; at other times syphilis or blastomycosis. The diagnosis is made by demonstration of the double contoured, endosporulating cells in the pus from the lesion, or in the stained sections of the tissue excised for this purpose. This should be further confirmed by cultural methods and by guinea-pig inoculation.

Cummins, Smith and Halliday,[1] in an epidemiologic survey of coccidioidal disease, collected 182 cases, the majority of which originated in California. East of the Mississippi River one case was collected from each of the following states: Illinois, South Carolina and Pennsylvania.

Recently the writer found this malady in a Negro, aged 36, a plasterer, with lesions on the right forearm and the right anal fold. This case originated, probably, in Tennessee.

It is probable that coccidioidal granuloma is widespread in this country.

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QUOTATIONS

BRITISH OPTICAL INSTRUMENTS

AN encouraging account of progress in the British optical instrument industry during the last five years is given in a memorandum prepared by the council of the British Optical Instrument Manufacturers' Association.

In the essential quality of transparency, British optical glass has always been superior to any made abroad. This superiority, it is stated, has been further increased in the last few years. Between 1885 and 1914 great advances were made in Germany in the production of glasses with new optical qualities, but the British remained superior in the manufacture of the finest quality of glass in large-sized disks, which present the greatest difficulty in manufacture. The Germans were pre-eminent only in the mass production of the smaller sizes, and in a larger range of kinds of glass. By 1928 the British manufacturers had extended their range of glasses, and in consequence of further advances since every durable and trustworthy kind of glass can now be obtained here. At the same time the ability to produce the very largest disks has been retained and even increased. Before the war the supply of spectacle lenses throughout the British Empire markets had very largely fallen into American hands. In recording gratifying advances in this field, the memorandum notes that of one particular make of spectacles developed and patented in this country 80 per cent. of the total production goes to the United States.

The memorandum states that the majority of cinema films, even in the United States, are made with lenses of British design made in Great Britain, and are also projected on the screen through British lenses. A range of instruments invented, patented, and made in this country was installed some years ago at the National Physical Laboratory for the testing of every kind of optical instrument, making it possible to state the results in numerical terms. Such tests, the memorandum points out, have established the superiority of the best British photographic lenses over the best made anywhere else. Part of this superiority is attributed to the new apparatus for testing. The two foremost manufacturers of photographic lenses in the United States and Germany, respectively, have recently purchased from the British inventor the right of using these test methods. Of prism binoculars it is reported that two of the highest class have been put on the market by a British manufacturer.

In the class of special surveying instruments, such as those used in the erection and maintenance of bridges, an instrument designed and made in Great Britain received, three years ago, the first prize offered by the German State Railways in a competition for

[1] W. T. Cummins, J. K. Smith, and C. H. Halliday, *Jour. Am. Med. Ass.*, 93: 1046, 1929.

such an instrument open to the world. British surveying instruments have been supplied in the last few years for use on the great Sydney, Zambesi, and Benue bridges, Takoradi Harbour, the Congo Boundary Commission, Egyptian dam construction, the 15-mile Lochaber water tunnel, and the preservation of St. Paul's Cathedral. Important developments of a few years ago in microscopes have been made accessible for the study of bacteria and other organisms, and of structures of the smallest sizes. The recent discoveries of the life history of the filter-passers have been chiefly accomplished in this country as a result of British improvements in instruments. Under the stimulus of Sir Robert Hadfield, a recent metallurgical microscope has been developed which, with other British inventions, has placed British metallurgists in a more favorable position than any of their rivals.

Strong as was the British position in 1925 in optical instruments for scientific research, which are the severest test of competence in manufacture and design, it is said to be even stronger to-day. Although some of the instruments which in 1926 were made only here are now made abroad, it is asserted that in quality no other country can equal them; and other instruments developed more recently in Great Britain are not made anywhere else. Britain is also the only country in which X-ray spectrographs are made by an optical firm of reputation. There is a British firm which makes four distinct types. In this achievement it has been directly helped by the remarkable work of Professor Laby, of Melbourne University, in the analysis of minerals by means of X-ray spectrographs, and the work done by the school of Sir William Bragg and Professor W. L. Bragg.—*The London Times.*

SCIENTIFIC BOOKS

The Life, Letters and Labours of Francis Galton. By KARL PEARSON, Galton Professor, University of London. Vol. III^{A} Correlation, Personal Identification and Eugenics. Pp. xii + 438. Frontispiece, extra plate; tail piece, 42 plates, and two loose charts. Vol. III^{B} Characterisation, especially by Letters, Index. Pp. 4 unnumbered + 232 numbered 441–672. 17 plates. Cambridge (University Press), 1930. 69 shillings for the two volumes.

NEARLY six years ago the first two volumes of this great biography were reviewed in SCIENCE (61: 209). Now, sixteen years after the appearance of the first volume, the work is complete. It will stand for all time as a monument to both subject and author. No other man of science ever had such a biography to preserve his memory.

These two final volumes are really one, as is indicated in the numbering, and are only bound in two for convenience in handling. The same infinity of painstaking care over the details of the production, illustration and documentation that marked the first two volumes is apparent here. In spite of advancing years it is still a firm and sure hand that penned these volumes.

This last volume deals, in its later parts, with the portion of Galton's life which was known at first hand by many persons now living. Obviously this has both advantages and disadvantages for a biographer (and in a minor degree for his reviewers). In this case it has led to a result which will be welcomed by Professor Pearson's old students. It is that the particularly full account of the last decade of Galton's life carries along with itself a good deal of autobiography of its writer. Regarding this Pearson says (III^{A}: vii):

> One apology I must make if the reader feels that in the chapter on the last decade of Galton's life the biographer has introduced too much of himself. To me that last decade was essentially bound up with our joint work for a subject we both had closely at heart; and I believe that for Galton himself our common aim—the establishment of Eugenics as an accepted branch of science—was a leading, if not the principal, purpose of those years. My own enthusiasm may possibly have deceived me, but I believed that Galton during that decade lived more in the struggles and difficulties of our infant Laboratory than in any other phase of his wide interests. The sympathy and help he always so readily tendered to his friends may again have misled me, but I think the history of the Laboratory he founded and finally endowed was also the essential history of his own life in those last years. At any rate such is the aspect of Galton's many-sided nature that I then saw most closely, and it is accordingly that which I am best fitted to render account of. To me his final crusade for eugenic principles was the crowning phase of a life whose labours in medicine, evolution, anthropology, psychology, heredity and statistics directly fitted him to be the teacher and prophet of the new faith.

There are three chapters in Volume III^{A}. The first of these deals with correlation and the application of statistics to the problems of heredity. Galton's first experiments on heredity began in 1875 with plants. He first attempted to get the relation between the weight of mother and daughter seeds of some plant like cress. Meeting with no success he turned to sweet pea seeds in the same year. From data in a notebook

of the time Pearson reproduces the first regression ever calculated, that between the diameters of parent and offspring peas. He comments as follows (p. 3):

It is strange that both Galton and Mendel should have started from peas, the former from sweet and the latter from edible peas. Galton tells us distinctly why he chose the former, namely because he would not be troubled to the same extent by variation in size of peas within the same pod. We must leave it to the future to judge whether the correlational calculus, which has sprung from Galton's peas, is or is not likely to be of equal service with the vast system of factorial genetics which has arisen from Mendel's peas—and this even in the theory of heredity. We see now what Galton might have done, he might have provided us with data to check Johansen's later bean-weight experiments, he might have thrown light on the "pure line." He might possibly have reached the correlation coefficient instead of the regression slope in his first attempt to get a measure of correlation. Whatever he might have done, he reached the idea of regression before he reached that of the coefficient of correlation. As long as he was dealing with heredity in the same sex, the approximate equality of variabilities in the two generations preserved him from any great error.

Following the plan used in Vol. II, Pearson proceeds in this first chapter to analyze, digest and criticize Galton's biometric contributions to the problems of genetics. His ideas on correlation and heredity culminated in "Natural Inheritance," published in 1889, when he was 67 years old. Pearson says that this book created Galton's school, and started Weldon, Edgeworth and himself off on the study of correlation.

Galton believed that evolution proceeded chiefly by discontinuous steps, through the occurrence and preservation of what we now call mutations, and he called "sports." He believed that while what he called "variations proper" were inherited, they were of no importance in evolution because of "the constant tendency to regress." Pearson points out that Galton's methodology had led him astray here. He says (p. 83):

In other words there is no "unexpected law of universal regression." Regression in Galton's sense arises solely from the fact that by clubbing into a single array the offspring of all fathers of a given character deviation he has given them not only mothers whose average stature will be mediocre, but also a mediocre ancestry. . . . Shortly, there is no law of "universal regression," and we can deduce from Galton's own theory that his "variations proper," if selected and inbred, would establish a breed with a "new center of regression." It is of course more than probable that our new center of regression, *i.e.*, the type of our new breed, may be unsuited to survive, that is to say in Galton's sense may be unstable. One can not alter one character in an organism without modifying all the correlated characters, and some of these altered are likely to have survival value. But Galton's own data and Galton's own theory rightly interpreted lead to no "universal regression," still less to an argument that "variations proper" can not be the subject of selection and the formation of new breeds.

This does not prove that "variations proper" have been the basis of evolution, but it removes Galton's chief reason for belief in evolution by discontinuity, that is by sports or mutations. The law of "universal regression"—over which Galton undoubtedly stumbled—is only true when we neglect ancestry beyond the parents and suppose mating at random, but these are not the conditions which exist when intense selection is taking place and the selected interbreed.

There is much meat in this first chapter for the biometrician, and also some highly amusing bits, like the "average flush of excitement," and the problem of how to cut a round tea cake, the consumption of which was to extend over three consecutive days, in such manner as to leave a minimum of exposed surface to dry. Galton solved the problem; Pearson is suspicious that Galton and his niece did not eat all the cake according to the solution, because on the third day roughly four sevenths of the residue to be eaten was dry rind. A mere American's experience with English tea cake, extending at odd intervals over more years than he likes to think of, leads him to the view that the whole problem was supererogatory. No known English tea cake ever had sufficient moisture at any stage of its evolution or degustation to make the manner of its cutting of the slightest importance!

The end of the chapter recounts, with much reserve, the story of the Royal Society's "Committee for the Measurement of Plants and Animals." The committee was appointed at Galton's suggestion in 1894. The members were Galton (chairman), Francis Darwin, Macalister, Meldola, Poulton and Weldon (secretary). In 1896 Pearson was added. This group wanted to measure plants and animals; in short to do biometry. But from the start they were pestered by a group of unbelievers, led by Bateson. In 1897 some nine new members, zoologists and breeders, were added, including Bateson. The committee was renamed, "Evolution (Plants and Animals) Committee of the Royal Society." By 1900 Pearson and Weldon had resigned, and later Galton dropped out. The victory, for the other side, was complete. The Reports of the Evolution Committee became the vehicles of publication for the major part of Bateson's early Mendelian experiments.

The second chapter deals with Galton's finger-print work. Finger prints were a major interest and occupied much of his time between 1887 and 1895. Pear-

son gives first an account of the history of the use of finger prints for personal identification and its official adoption in England. Following this comes the story of Galton's attempts to popularize the method, and finally there is a résumé of his scientific contributions to the subject. This chapter is very fine. It lays down and documents a record which will make it forever impossible to take from Galton's memory the credit for building the foundation upon which all subsequent work on finger prints has been based, and particularly that part of it involving the official use of finger prints in criminal identification. The history of the matter is interesting. In the popular mind there is a wide-spread tendency to think of Bertillon as the originator of the use of finger prints for identification. As a matter of fact Galton introduced Bertillon to the method, as the latter himself acknowledged in a letter written in 1891. Actually the first *use* of finger prints for administrative purposes had been by Sir William Herschel in India as early as 1858. The merits of the claims of a Dr. Faulds to have been the pioneer in the field, put forward in definitive form in 1905, belittling the work of Herschel and Galton, are dealt with by Pearson as they deserve to be. The chapter ends with the following words (p. 215):

> The reader who has had the courage to follow Galton's biographer through the intricacies of this chapter will, I am sure, be convinced not only of the labor Galton devoted to his finger-print studies but also of the amazing energy he exhibited in acquainting not only administrative bodies but the public at large with the possibilities which then lay hidden in finger-printing, and this not solely for scientific but also for practical purposes. If the reader can find anyone who before 1895 had published a tithe of what Galton had issued on this topic, then I will admit him also to be a pioneer; if he can find anyone who has since 1895 done more than amplify in minor, often in very minor points Galton's work, then I will admit him a worthy successor to Galton.
>
> Finger-printing as a science and finger-printing as an art are both alike the product of Galton's insight, ingenuity and tireless activity; the attempts to belittle the credit due to him can only spring from those who for their own purposes choose to ignore the literature of the subject.

The third and last chapter, the longest in the whole work, is entitled "Eugenics as a Creed and the last Decade of Galton's Life." It will form the prime source authority for future students of the eugenics movement which flourished in the first half of the twentieth century. Galton started it. Pearson has lived through the flow of the tide. To this chapter all future workers will turn, who may be curious to know what happened. Furthermore, to those now living who are interested in and at all acquainted with the politics of science in England since 1900, this chapter will furnish mildly spiced reading. The battle royal between the Bateson and the Pearson schools, in which, as usual, neither side got all the spoils, but each got some, is handled with extreme discretion, but still with a sufficiently forthright clarity.

As a piece of historical writing this chapter is of great value. But one is reminded of a remark which has been attributed—I believe correctly, though I have not succeeded in running down the exact *locus* of the quotation—to one of England's greatest sons. It is this: "Science commits suicide when it adopts a creed." The story of the last ten years of Galton's life emphasizes the fact that these eight words quoted contain much wisdom. "Eugenics as a creed" makes its appeal to crusaders. Its idols tend to be either those of the forum or those of the cathedral. The record plainly shows that Galton became successively annoyed, harassed and finally appalled by some of the consequences of the thing he had started. Towards the end of his life he withdrew himself just as completely as possible from any connection with organized eugenics, with the exception of the Eugenics Laboratory under Pearson's direction. If these four great volumes before us demonstrate anything about Galton it is that he was enormously more a pioneer than a crusader.

The time has not yet come when an entirely realistic discussion of the origin and development of the eugenics movement will be possible. It is much too near us. Galton, in 1907, gave the money necessary to start the Eugenics Laboratory at University College. Later, in a codicil to his will, he permanently endowed it. That laboratory has made contributions of great value to the science of human genetics, under the guidance of Professor Pearson. This is what Galton primarily wished to accomplish by his gift. In his forty-second year he said: "I shall treat of men and see what the theory of heredity of variation and the principle of natural selection mean when applied to man," and, as Pearson remarks, this treatment only ended with his life. A scant three months before his death he wrote of the work of Eugenics Laboratory: "I hold it to be thoroughly scientific and most valuable, and I rejoice that I was its founder."

Volume III^{B} includes one long chapter composed chiefly of letters, and a very detailed and thorough index of the whole work. The letters are, for the most part, family letters, and are delightful. The index is a model.

And so comes to an end a remarkable, indeed a unique, piece of biographical work, a fitting and adequate record of a great man.

RAYMOND PEARL

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

HINT FOR BETTER GEOLOGICAL PHOTOGRAPHS

FOR years the writer has been dissatisfied with the mediocre results of his numerous attempts to photograph sand dunes, clay banks and other light-colored features in which contrast was deficient. Recently, following a hint from Dr. John E. Wolff, of Pasadena, he tried the use of a dark violet ray-filter. The results were splendid. Details such as fine ripple-marks on sand dunes stood out sharp and clear. In photographs of gravel banks each small pebble was distinct. In general almost every near-by object was beautifully rendered, and this was especially true of the light-colored ones.

The utility of this ray-filter in photographing landscapes seems to be limited to the immediate foreground. Up to distances of about 100 feet it gives excellent results; at 1,000 feet it is of doubtful value; and at the distance of a mile there is serious loss of detail and contrast, as compared with ordinary photographs taken without a ray-filter.

Geologists who need photographs of road cuts, gravel banks, quarries, rock outcrops, and other features of that nature, as well as desert surfaces, sea beaches, and all sorts of sedimentary deposits, will probably find this simple device useful, as it will enable them to obtain photographs that will make excellent half-tone illustrations and will possess unusual clearness of detail. Since the length of exposure must ordinarily be multiplied by ten when the violet ray-filter is used, the latter will not ordinarily be practical for simple hand cameras without tripods, especially as it is generally necessary to use a small diaphragm aperture in order to secure depth of focus in the foreground.

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A SIPHON MOIST CHAMBER

I HAVE just read an article by Florence A. McCormick in the January 30 number of SCIENCE, entitled "A Siphon Moist Chamber for Microscopic Mounts." A question has arisen in my mind concerning one statement that is made in this article: "A mount can be made in a nutritive solution and with this method the concentration will not be changed." Since there is a constant evaporation from the edges of the coverglass and the solution is being added to from the wick, it seems to me that the concentration under the coverglass will be increasing because of the loss of moisture from around the edge which in turn is replaced by a nutrient solution. This difficulty, however, could be overcome by using a nutrient solution in the first place and then replacing the water lost by evaporation by distilled water through the wick. I realize that there may be a tendency for some of the nutrient solution to pass back into the wick and thus dilute the concentration slightly, but it seems doubtful under the conditions as to whether this would be of any consequence and certainly would not be as great a factor as the concentration of the solution would be where a nutrient solution is used to replace the water lost by evaporation.

C. C. THOMAS

SPECIAL ARTICLES

A DIRECT QUANTITATIVE RELATIONSHIP BETWEEN VITAMIN A IN CORN AND THE NUMBER OF GENES FOR YELLOW PIGMENTATION

IT has been known for some years that yellow corn is richer in vitamin A than white corn.[1] A similar association between vitamin A and carotinoid pigments has been discovered in many other materials; also there are numerous cases in which this association does not occur. Since the carotinoid pigments in the endosperm of corn are known to be inherited in definite Mendelian ratios, and since the technique for estimating the amount of vitamin A has been perfected to a degree of reasonable reliability, the writers have felt that estimations of vitamin A in seeds resulting from different doses of the gene for yellow pigment would throw additional light on the association of the carotinoid pigments with the nutritional factor and might also have some bearing on the behavior of the gene. Accordingly, work on this problem was undertaken in 1928. Steenbock and Boutwell[1] had already shown that, on ears segregating for white and yellow endosperm, the deep yellow seeds were higher in vitamin A than a mixture of the pale yellow and white seeds. After our work was started, a paper by Hauge and Trost[2] reported that the white seeds on segregating ears of a cross between yellow and white are no more effective in promoting growth than seeds of the white-seeded parent. Both these investigations indicate strongly an association of yellow pigment with vitamin A in inheritance but neither shows the quantitative relation of the nutritional factor to different doses of the gene involved. In fact, Hauge and Trost found the light yellow seeds, which were a mixture of two genotypes, to be apparently as effective in promoting growth as the deep yellow seeds.

The endosperm of corn, as of most of the angio-

[1] H. Steenbock and P. W. Boutwell, *J. Biol. Chem.*, 41: 81.

[2] S. M. Hauge and J. F. Trost, *J. Biol. Chem.*, 80: 107.

sperms, is the product of a sexual fusion in which two maternal nuclei combine with one pollen nucleus. Consequently, it is triploid in its chromosomal constitution. This has been repeatedly demonstrated, both cytologically and genetically. The triploid nature of the endosperm makes it possible to produce four classes of seed differing in the proportion of dominant and recessive genes. In the case of the factor for yellow pigmentation, the cells of the endosperm may have 0, 1, 2 or 3 genes for yellow pigment with the corresponding factorial composition *y y y*, *y y Y*, *y Y Y* or *Y Y Y*. These four classes differ in color and may be described roughly as white, pale yellow, dilute yellow and deep yellow. If all types occur on the same ears it is often difficult to make an accurate classification, especially between the two intermediate classes. By making appropriate pollinations, however, they can be separated with a high degree of accuracy.

In 1928 pollinations were made to produce these four classes of seeds. Surecropper, a white-seeded variety, and Ferguson's Yellow Dent, a yellow-seeded variety, were pollinated by a mixture of pollen from both sorts. On the ears of the white-seeded variety two types of seeds were produced, white and pale yellow, having, respectively, 0 and 1 factors for yellow endosperm. On the ears of the yellow seeded variety two additional types, dilute yellow and deep yellow, were produced, having, respectively, 2 and 3 factors for yellow endosperm.

The vitamin assay of these four classes was made by feeding to albino rats according to the Sherman-Munsell unit method.[3] The results in 1928 showed a high degree of association between the number of genes for yellow pigment and the number of units of vitamin A per gram of material. The pollinations and vitamin estimates were repeated in 1929 with corn grown under different seasonal conditions. Again, almost complete association was shown. The average results for two years are shown in the following table:

No. of genes for yellow	Factorial composition of endosperm	Units of vitamin A per gram		
		1928	1929	Average
0	*y y y*	0.05	0.05	0.05
1	*y y Y*	2.50	2.00	2.25
2	*y Y Y*	5.00	5.00	5.00
3	*Y Y Y*	7.00	8.00	7.50

These results show, first, that a white-seeded variety of corn, which ordinarily has little or no vitamin A in the endosperm, is capable of forming this substance in its seeds if the gene for yellow pigmentation is introduced. The white and pale yellow seeds were produced by the same plants, the only difference between them being in the microscopic pollen nuclei which entered into the fusion to produce the endosperm.

The next point of interest is that there is a direct quantitative relationship between the number of genes for pigmentation in the cells of the endosperm and the amount of vitamin A in the seed. Each gene for yellow induces the formation of approximately 2.5 units of vitamin A per gram of seed. The obvious conclusion must be that the gene for yellow pigmentation is responsible for the formation of vitamin A, either directly, or indirectly, with the production of carotinoid pigments as an intermediate step.

Finally, these results may have some bearing on the chemical nature of this particular gene. So far as we are aware, this is the first case in which it has been possible to establish, with any degree of exactness, a direct quantitative relationship between different doses of the same gene and their chemical effect. Although even this tells us little of what the gene may be, it does, perhaps, furnish some indirect evidence of what the gene is not. It seems scarcely probable, for example, that this gene functions as an enzyme, since the total reaction resulting from enzyme activity is seldom closely related to the concentration of the enzyme, while each gene for yellow pigment seems to govern the formation of a definite quantity of vitamin A. It is true that the rate of a reaction in which an enzyme is involved varies with the concentration of the enzyme, but the proportion is usually not a direct one like that shown here.

The straight-line relationship between the number of genes for yellow pigmentation and amounts of vitamin A is more indicative of a direct chemical reaction between the gene and some other substance which is present in the cells of the endosperm of both white-seeded and yellow-seeded varieties of corn.

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[3] H. C. Sherman and H. E. Munsell, *J. Am. Chem. Soc.*, 47: 1639.

A DIFFERENTIATION OF THE SO-CALLED ANTIPELLAGRIC FACTOR, VITAMIN G[1]

IN February of 1926 Goldberger and coworkers[2] and Smith and Hendrick[3] have demonstrated the dual nature of vitamin B. In May of the same year Goldberger and Lillie[4] submitted evidence that a deficiency of the stable factor in a diet fortified with an abun-

[1] Research Paper No. 142, Journal Series, University of Arkansas.

[2] Goldberger, Wheeler, Lillie and Rogers, Pub. Health Rep., 1926, 41: 297–318.

[3] Smith and Hendrick, *ibid.*, 1926, 41: 201–207.

[4] Goldberger and Lillie, *ibid.*, 1926, 41: 1025–1030.

dance of the labile, antineuritic substance resulted in a pellagra-like disease in the rat. Following the arrest of growth, alopecia and bilateral symmetrical lesions of the skin were the most noteworthy symptoms noted. Although the work of Goldberger and associates has in the main been substantiated in this country and England, Salmon, Hays and Guerrant,[5] and Chick and Roscoe[6] have suggested the complicity of the antipellagric dietary essential, since occasionally animals deprived of this syndrome remain stunted in growth but exhibit no skin lesions.

During the past two years, while engaged in studies of the biochemistry and pathology[7] of the pellagra-like avitaminosis in the albino rat, we have had occasion to observe various manifestations of the so-called vitamin G deficiency in 125 animals. The disease was produced by one of us (B. S.) on a dietary régime described elsewhere.[8] The optimum ration for the production of the dermatitis was found to be one deficient in the vitamin B complex, supplemented by a daily allowance of 500 mg of rice polishings, irradiated for 10 hours, according to the suggestion of Hogan and Hunter,[9] in order to insure the destruction of the greater portion of vitamin G. To summarize our results of 1929, the majority of the animals in which pellagra-like symptoms were produced showed dermatitis 20 to 50 days preceding the cessation of growth. On the other hand, our experience with other vitamin G deficient diets has been that the majority of animals failed in growth markedly without any accompanying skin lesions; and we would like to point out in this connection that all our rations were amply fortified with the antineuritic, growth-promoting factor. We have repeated our experiments of 1929 and have corroborated our former findings that there is no relation between failure in growth and the incidence of pellagra-like symptoms in the rat, the dermatitis being prevalent in some animals that make normal growth and absent in others that are first stunted in growth for weeks and months, and that finally collapse following great losses of weight. Recently we found accentuated dermatitis in six positive controls, out of 12 studied, accompanying excellent growth, the males having attained a weight of 240 to 270 grams and the females a weight of about 200 grams. The rations of the positive controls contained 10 per cent. autoclaved yeast as a source of vitamin G, and irradiated rice polishings as a source of vitamin B. Since we autoclave our yeast (Northwestern) at 20 pounds pressure for 6 hours, it is quite possible that, under our conditions, we are destroying the greater portion of the antidermatitis factor, at the same time not injuring the relatively stable growth-promoting factor. We, therefore, conclude that the so-called vitamin G is composed of two dietary essentials: one the deficiency of which produces pellagra-like symptoms in the rat; and another the deficiency of which produces a decline of growth.

Since the nomenclature of the so-called antipellagric factor is still in a state of confusion, the English investigators calling it vitamin B_2, while the American biochemists refer to it as vitamin G, the letter F of the vitamin alphabet having been left unrepresented,[10] we suggest a logical home for the letter F and have it indicate the stable growth-promoting factor associated with the vitamin B complex, and that we retain the letter G for the antipellagric factor, the deficiency of which produces the characteristic skin lesions in the rat.

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LIVER EXTRACT AS A SOURCE OF VITAMINS B AND G[1]

SOME of the early investigations of the distribution of vitamins showed that the livers of animals were a good source of vitamin B (vitamin B + G). More recently liver and liver extracts have been widely used in the treatment of pernicious anemia.

Curtis and Newburgh[2] last year reported some feeding tests with liver extract. They found that when 2 per cent. of liver extract (Lilly) was added to a basic diet containing no other source of vitamin B, growth and energy ingestion were approximately normal; the replacement of liver extract by equal amounts of yeast vitamin powder (Harris) caused less growth and less energy ingestion. If the liver extract was autoclaved before feeding, all the experimental animals developed polyneuritis. These tests indicated that liver extract was a good source of both vitamins B and G but gave no information regarding the relative richness of the substance in the separate factors.

[5] Salmon, Hays and Guerrant, *J. Inf. Dis.*, 1928, 43: 426–441.

[6] Chick and Roscoe, *Biochem. J.*, 1927, 21: 698.

[7] Thatcher and Sure, Arch. of Path., in press.

[8] Thatcher, Sure and Walker, *So. Med. J.*, 1930, 23: 143.

[9] Hogan and Hunter, *J. Biol. Chem.*, 1928, 78: 433–445.

[10] Report of Committee on Nomenclature of American Society of Biological Chemists, SCIENCE, 1929, 69: 276.

[1] Read before the Biological Section, Alabama Academy of Science, Auburn, Alabama, April 18, 1930.

[2] A. C. Curtis and L. H. Newburgh, "The Effect of Liver and Liver Extract upon Appetite," *Jour. Clin. Inv.*, 7: 518, 1929.

We were primarily interested in determining whether one of the commercial liver extracts[3] would offer a good source of vitamin G for further concentration of the active factor.

EXPERIMENTAL

Rats averaging 45 gms in weight were fed Diet 2B consisting of extracted casein 18, salts (No. 186) 3.7, agar 2, corn starch 69.3, butterfat 5, and cod-liver oil 2 parts for a preliminary depletion period of two weeks. The rats were fed in groups during this preliminary period; they were then placed in individual cages and given the test material, fed separately from the basal diet. Preliminary tests on 0.05 and 0.10 gm of liver extract per rat daily indicated that these dosages did not furnish a sufficiency of vitamins B and G for normal growth; on the 0.05 gm dosage there was rapid development of beriberi; even on 0.10 gm there was eventual development of beriberi. Later tests were conducted on daily dosages of 0.10 and 0.20 gm both with and without an added vitamin B supplement. The vitamin B supplement was prepared by adsorbing on fuller's earth the vitamin B from a concentrated alcoholic (80 per cent. alcohol by weight) extract of white corn.[4] Tests were simultaneously conducted upon a high-grade brewer's yeast for comparison. The average gain per rat during a period of nine weeks following the two weeks' preliminary period is shown below.

AVERAGE GAIN PER RAT FOR NINE-WEEK EXPERIMENTAL PERIOD

	Gms
0.10 gm liver extract	3.0
0.20 gm liver extract	65.0
0.10 gm liver extract plus 0.05 gm vitamin B solid	172.0
0.20 gm liver extract plus 0.05 gm vitamin B solid	165.0
0.05 gm brewer's yeast	21.0
0.10 gm brewer's yeast	53.0
0.10 gm brewer's yeast plus 0.05 gm vitamin B solid	51.0
0.20 gm brewer's yeast plus 0.05 gm vitamin B solid	72.0
0.05 gm vitamin B solid	11.0

It is evident that the liver extract tested is an excellent source of vitamin G, 0.10 gm per day furnishing a sufficiency of this factor for normal growth of the rat through an experimental period of nine weeks. It is not such a good source of vitamin B; 0.10 gm per rat daily as the sole source of this factor produces some increase in weight for a few weeks but the initial increase is followed by a decline in weight and the onset of beriberi. The liver extract tested apparently contained four or five times as much vitamin G but only about one fifth as much vitamin B as the sample of brewer's yeast. The vitamin B content of the extract compared favorably with the vitamin B content of the pure dried baker's yeast which we commonly obtain on the market.

W. D. SALMON
N. B. GUERRANT
ALABAMA POLYTECHNIC INSTITUTE

[3] The extract (No. 343) was kindly furnished by Eli Lilly and Company.

[4] W. D. Salmon, N. B. Guerrant and I. M. Hays, "The Effect of Hydrogen Ion Concentration upon Adsorption of the Active Factors of Vitamin B Complex by Fullers' Earth," *Jour. Biol. Chem.*, 80: 91, 1928.

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DE ALBENINO, NICOLAO. *Verdadera relacion delo sussedido enlos Reynos e prouincias del Peru desde la yda a ellos del Virey Blasco Nuñes Vela hasta el desbarato y muerte de Gonçalo Piçarro (Sevilia, 1549).* Institut d'Ethnologie, Paris. 45 fr.

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COLE, LAWRENCE W. *Factors of Human Psychology.* Second edition, revised. Pp. 612. 42 figures. University of Colorado Press.

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GINZBURG, BENJAMIN. *The Adventure of Science.* Pp. xvi + 487. Simon and Schuster. $5.00.

GRIAULE, MARCEL. *Le Livre de Recettes d'Un Dabtara Abyssin.* Pp. x + 180. 140 figures. Institut d'Ethnologie, Paris. 70 fr.

HOLT, EDWIN B. *Animal Drive and the Learning Process.* Volume I. Pp. vii + 307. Supplementary essay. This Material World, by Harold C. Brown. Holt. $2.50.

JEANS, SIR JAMES. *The Universe Around Us.* Second edition, revised. Pp. x + 351. Illustrated. Macmillan. $4.50.

LAHEE, FREDERIC H. *Field Geology.* Third edition. Pp. xxxi + 789. 538 figures. McGraw-Hill. $5.00.

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